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THE DIAGRAMMOMETER.

THE diagrammometer is an apparatus of measurement that permits of quickly calculating all the elements of a diagram or of a curve, figuring numerical data by means of gravity. The present model, shown in Fig. 1, is but an experimental device, which shows all the advantages that may be derived from more special instruments adapted to the various needs of calculators. In the near future it will become the universal calculating instrument for the engineer, the physicist, the chemist, mineralogist, the physician, the meteorologist, the statistician, the agriculturist, the banker, the manufacturer, the accountant, and the business man.

This apparatus differs from all calculating instruments known up to the present in that it permits not only of solving a large number of problems, but is actuated by gravity. Up to the present there are hardly more than two or three apparatus of this kind known, these being imitations of Cassini's arithmetic balance described in the *Recueil des Machines de l'Academie des Sciences de Paris* (*tome I.*, 1699), and the balance of Mr. Lalanne, senator and inspector general of bridges and highways.

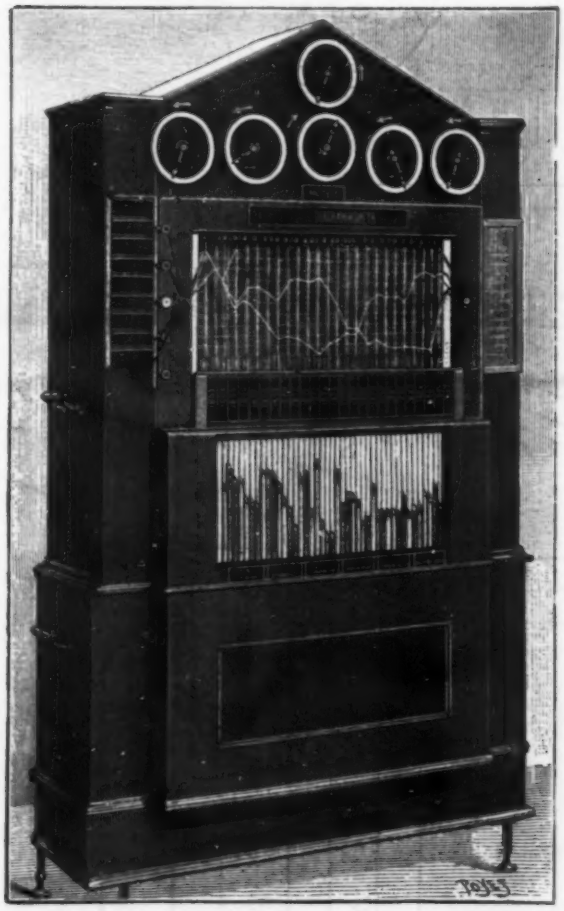


FIG. 1.—KOZLOFF'S DIAGRAMMOMETER.

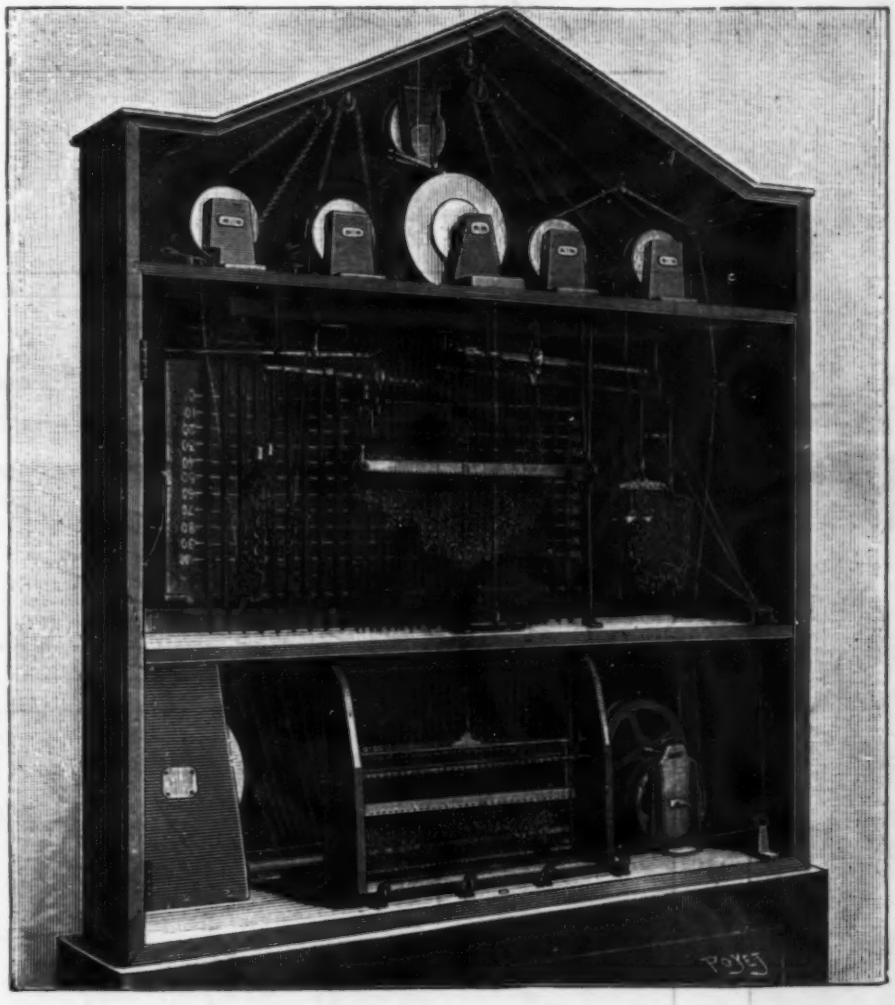


FIG. 2.—INTERNAL MECHANISM OF THE DIAGRAMMOMETER.

The diagrammograph is a tablet situated in a vertical plane (represented at the bottom of Fig. 1) upon which equidistant vertical and horizontal lines are drawn. In front of the tablet are arranged vertical slides that can be raised or lowered at will. In this way there may be figured a diagram or any curve whatever, conformably to the system of co-ordinates of Descartes' analytical geometry.

The slides are numbered horizontally from left to right, and represent the abscisses. The different heights of the slides with respect to any horizontal whatever represent the ordinates. We can, therefore, instantaneously figure a diagram corresponding to a table of figures, and thus produce graphic figures of all sorts. Upon taking the time measured in minutes and seconds for abscisses, the ordinates may figure the trajectory of a projectile, the peculiarities of the motion of parts of a machine, expansions and temperatures, and, in general, all the phenomena that are functions of the time. Upon taking the hours of the day as abscisses, the ordinates may represent the temperature, the barometric pressure, the hygrometric state, the velocity of the wind, the pulse and temperature of invalids, etc. Upon taking the days of each month, the months of the year, or the years of a century as abscisses, the ordinates may represent the course of exchange and of financial values, the receipts and expenses of a business man, the various budgets of states and cities, the mean temperatures and pressures, and the size and price of crops, the results of statistics of births, deaths, etc. In a word, the diagrammograph permits of immediately representing, in a visible manner, the results of a table of figures and the study of the phenomena of the sciences of observation and of statistical work. It is the phenomenonograph *par excellence*, the true exhibiter of phenomena. But this part is independent of the rest of the apparatus, and might be detached from it were it necessary. Just above the central part of the apparatus (Fig. 1) may be seen another diagrammograph, in which the slides are replaced by vertical wires along which slide rings or travelers. A colored cord passes through all the rings. Upon raising or lowering the latter, we obtain a diagram through the cord drawn at its two extremities by drums with springs. The apparatus is so arranged that as many as five diagrams may be figured at the same time, through cords of different colors. But it suffices to consider but one of these diagrams.

To each of the rings of the diagram there corresponds a vertical chain (Fig. 2) hooked to the beam of a scale. When the movable ring is raised to a certain height, the lower end of the chain rises to the same degree and bears no longer upon the beam than by a weight proportional to the length figured by the ordinate. Consequently, if we represent a diagram upon the apparatus, the effective weight of the chains will permit of determining the arithmetic mean of the ordinates. Other levers carry chains connected by wires with the rings of the same diagram, and the motion of the ring produces various arrangements of the chains.

At the upper part of Fig. 1 are represented dials called measurers. In the direction from left to right there are: (1) Mean; (2) probability; (3) intensity; (4) mean maximum; (5) probable motion; and (6) the general *resume*. Dial 5 measures the length of the diagram by means of a drum. In order to make use of the others, the lever of the large hand is so acted upon as to render the small, lower hand horizontal, and we read in hundredths the indications of the five measurers which give (1) the arithmetic mean of all the ordinates; (2) the arithmetic mean of the deviation of each of the ordinates, with the mean value; (4) the arithmetic mean of the ordinates greater than the mean; (5) the probability of the ascending or descending movement of the ordinates; (6), finally, the general *resume* permits of uniting in a single mean the results indicated by the other measurers.

The principles and details of construction of this apparatus are very ingenious, and have received the approbation of Mr. Marey, member of the Institute, who has furnished the inventor with extensions of the apparatus for space with three dimensions, and has named the new apparatus the stereogrammeter. Mr. Marcel Deprez, of the Institute, has warmly congratulated the inventor, and Messrs. Gariel and Cheysson, government engineers, Colonels Laussedat, Mannheim and Quinemant, Mr. Matrot, engineer in chief of the mines, and Messrs. Guieysse, Janet, Lemoine, Masson, Campion and other engineers have approved of the various applications of the apparatus, as has also Dr. Bertillon, chief of municipal statistics.

The apparatus remained on exhibition at the Conservatory during the month of July. It will be presented to the members of the Congress of Limoges by the French Association for the Advancement of Sciences. Then Colonel Kozloff will return to the Caucasus in order to improve his apparatus and give them their definite form.—*La Nature.*

INSTRUMENTS FOR DRAWING CURVES.

By Prof. C. W. MACCORD, Sc.D.

IX.—THE QUADRATRIX AND THE SUBQUADRATRIX.

LET the quadrant A B, Fig. 1, be divided into equal parts by radial lines, and the radius C B into the same number of equal parts by a series of horizontal lines; the intersection of each radius with the corresponding horizontal will be a point on the curve V B, which, by dividing the next quadrant B E in like manner, and continuing the equal divisions on the prolongation of C B, may be extended through P, as shown, to any desired distance to the right. This curve, known as the quadratrix of Dinostratus, will evidently have a horizontal asymptote D M, the distance C D being equal to the diameter A E of what is called the generating circle; and will be symmetrical about the horizontal axis through C.

The points on this curve, then, are the intersections of a radius rotating uniformly about C, with a horizontal line moving uniformly in a vertical direction. If the rotation be continued beyond E, the horizontal line still moving upward, a new branch, of a different

form, will result; thus, bisecting E I at H, and setting off D J = ½ C B, we see that H C produced will cut the horizontal through J in a point L, and so on. This new branch Q R will cut the vertical line through C in a point F, the distance D F being equal to C B; when produced to the left it will evidently have D M for an asymptote, while if continued to the right it will be asymptotic to the horizontal G N, the distance D G being equal to A E, the diameter of the generating circle. In a similar manner, another branch may be formed above G N, and so on indefinitely; each of these branches being of course symmetrically repeated on the opposite side of the axis.

In Fig. 2 is shown a device for drawing this curve mechanically by continuous motion. The frame is composed of two longitudinal bars L L, connected by two transverse bars T T; the former serving also as guides for a traveling bar F F, in which is a long slot S S. Sliding freely in this slot is a block B, forming slot S S before replacing the rack, and it needs no argument to show that the form of the curve traced by this mechanical movement will depend upon the position which is selected in thus putting the parts together.

In Fig. 3 the slotted lever is horizontal, and the pivot K of its controlling block is fixed at the point of contact between the pitch circle W and the pitch line R R of the vertical rack. If now the wheel be turned to the right, it will tend to roll upward on the rack, which it can do only by a rotation of the lever to which it is fixed, about the center K, in the same direction and with the same angular velocity. After one fourth of a rotation, the lever being vertical, the center O must be at O', the distance K O' being equal to the quadrant K I; and the radius O I will have the position O' I'. As shown by the dotted radii and horizontals, the path of O is the quadratrix, the radius of whose generating circle is K O'.

circle, corresponding to C F in Fig. 1), the curve will be an exterior branch of the quadratrix.

In Fig. 5, on the other hand, K O' is less than in Fig. 3. The effect of a rotation to the right will obviously be to describe the curve O P, to which T T is asymptotic, as in Fig. 4. But on the left of O' the form of the curve will be very different; O' K is a definite fraction of O' S, and when the lever has turned through that fraction of 90°, its center line then having the direction K X, the center of the wheel will coincide with K, through which point the curve, having turned to the right, will pass, and, if continued, will have S S for an asymptote.

It is obvious that exterior branches may be formed, related to the curve K O' P in Fig. 5, somewhat as Q F R is related to the quadratrix in Fig. 1; and that they may be traced mechanically by the device shown in Fig. 2, if the lengths of the rack and the slotted lever are made sufficiently great in proportion to the

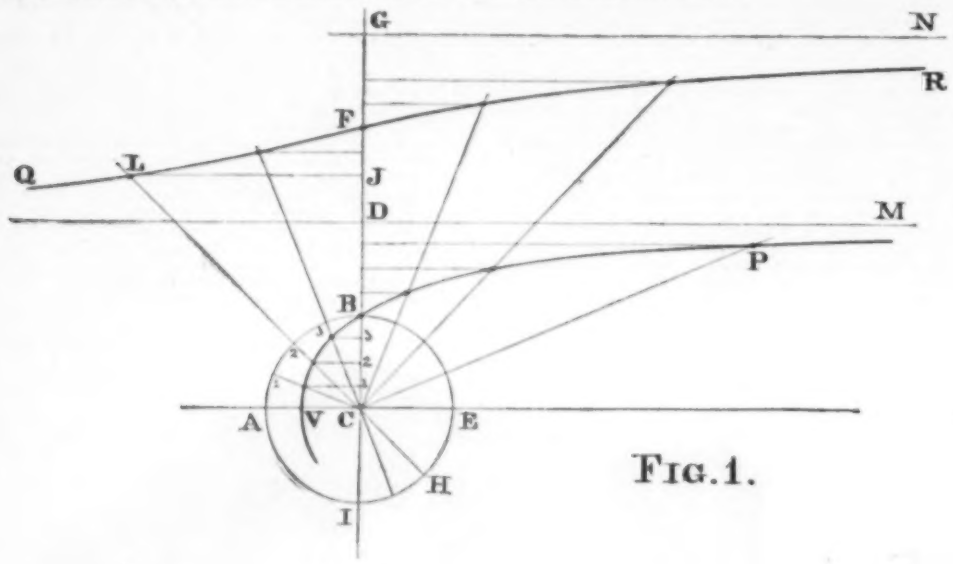


FIG. 1.

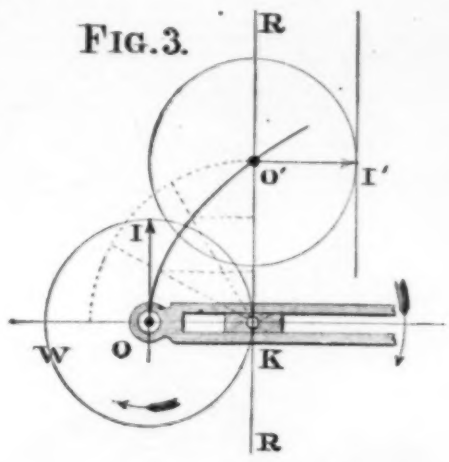


FIG. 3.

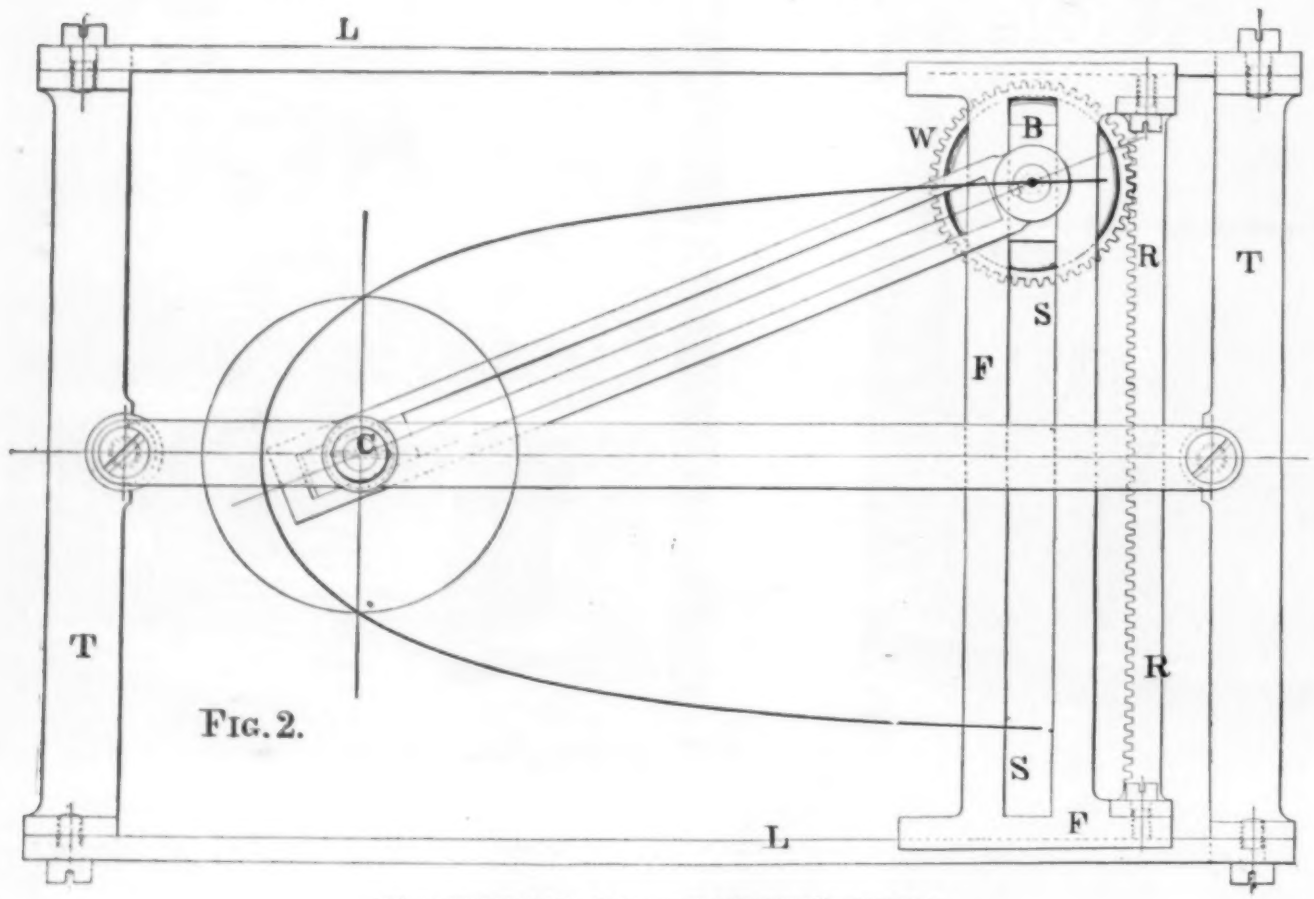


FIG. 2.

INSTRUMENTS FOR DRAWING CURVES.

the bearing for the shaft upon which is keyed the wheel W, the circumference of whose pitch circle is equal to twice the diameter of the generating circle of the curve. This wheel engages with a rack R, secured to the bar F; thus both wheel and rack are free to move longitudinally, while the wheel in rotating will travel transversely. The shaft of W, extending downward, is centrally drilled to form a pencil holder, and extending upward, it has keyed upon it, above the bearing, a long slotted lever, whose motion is controlled by means of a block which is fitted to its slot, and is also pivoted at the center of the generating circle, to a third longitudinal bar secured to standards formed on the transverse bars T T.

It will be seen, then, that as the bar F, with the rack and wheel, move to the left, the slotted lever will be made to turn about the center C, which again will compel the wheel to roll along the rack, with a linear velocity directly proportional to the angular velocity of the rotation, thus describing the curve shown.

Now if we suppose the rack to be removed, it is clear that the block B may be placed at any position in the

This then shows how the apparatus must be adjusted in order to draw this curve, and also how the position of the vertex is determined. From this central position the lever can turn in either direction, through an angle limited only by the length of its slot, as will be clear from a glance at Fig. 2.

The effect of changing this adjustment can be best shown by placing the lever in a vertical position.

Thus in Fig. 4, let the distance K O' be greater than in Fig 3, by any arbitrary amount. A quarter revolution of the wheel to the left, would cause it to descend through the distance O' S, while a quarter turn to the right would raise it through the equal distance O' T. But either would require the lever to turn through the same angle about K, bringing it into a horizontal position, in which event its center line would meet the horizontals through S and T only at an infinite distance: those lines will therefore be asymptotes to the path of the center O', which, as shown, will be a curve of contrary flexure. And if the distance K O' be made equal to three fourths of the circumference of W (or one and a half times the diameter of the generating

diameter of the generating circle, without any other modification.

THE SUBQUADRATRIX.

In Fig. 7, the radius C B is divided into any number of equal parts by horizontal lines, and the quadrant B E into the same number of equal parts by radial lines; and the intersections of the horizontals with the corresponding radii in their order, as indicated by the numerals, are points on the curve C P Q.

Each radius used in the construction of this new curve, it will be noted, is perpendicular to the corresponding radius of the quadratrix, V B T, as shown by the shaded triangles. And, although B D is the horizontal asymptote to C P Q, the relationship between the two curves is not confined to the portion V B of the quadratrix, as may be thus shown. Through any point R of the new curve draw C R, and to it a perpendicular through C, cutting the quadratrix in F; then by the construction F R, which cuts C B in G, is horizontal. Draw R T perpendicular to C R and equal to C F; also draw T J perpendicular to C B, T H perpendicular to F R, and join T C. Then the similar

and equal triangles T H R, C G F, give T H=C G, therefore C J is twice C G. Also from the similar triangles F C R, T R C, the angles F R C, T C R are equal; but F R C=R C E, therefore the angle T C E is double the angle R C E, which again is equal to F C G. Consequently, subtracting T C E from 180°, and F C G from 90°, we have the angle A C T equal to twice the angle A C F; whence it follows that the point T lies upon the continuation of V B; the new curve may, therefore, be very properly named the subquadratrix.

The curve C P Q will obviously be symmetrically repeated below the horizontal axis through C, which is the vertex of this interior branch. It is equally clear that by continuing the rotation of the radius, exterior branches, similar in form to those shown in Fig. 1 and Fig. 4, will be formed; which might be drawn by means of the instrument shown in Fig. 2, by properly adjusting the distance of the center of the wheel W above the central axis when the lever is vertical.

It needs but a moment's reflection to perceive that the subquadratrix is but the special form of the curve K O' P in Fig. 5, which results when K O' becomes zero in that diagram; or in other words, when the center of the wheel coincides with the fixed center about which the lever rotates, at the instant when the lever itself is vertical. In order to draw this curve, then, or indeed any one of the varieties of which Fig. 5 is a

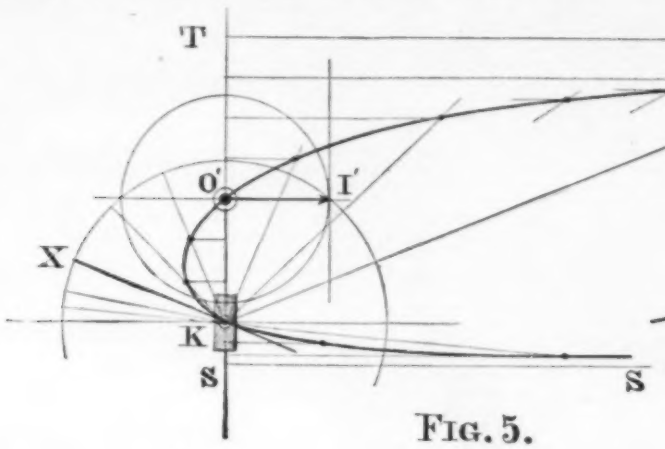


FIG. 5.

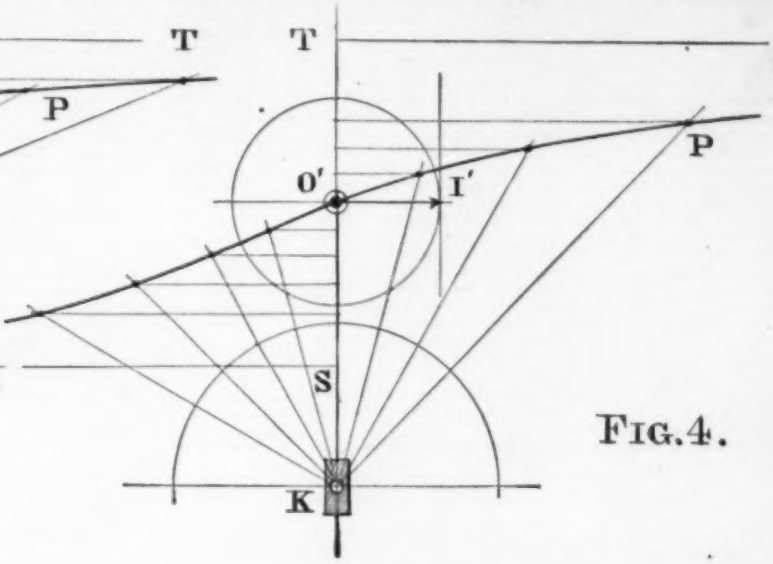


FIG. 4.

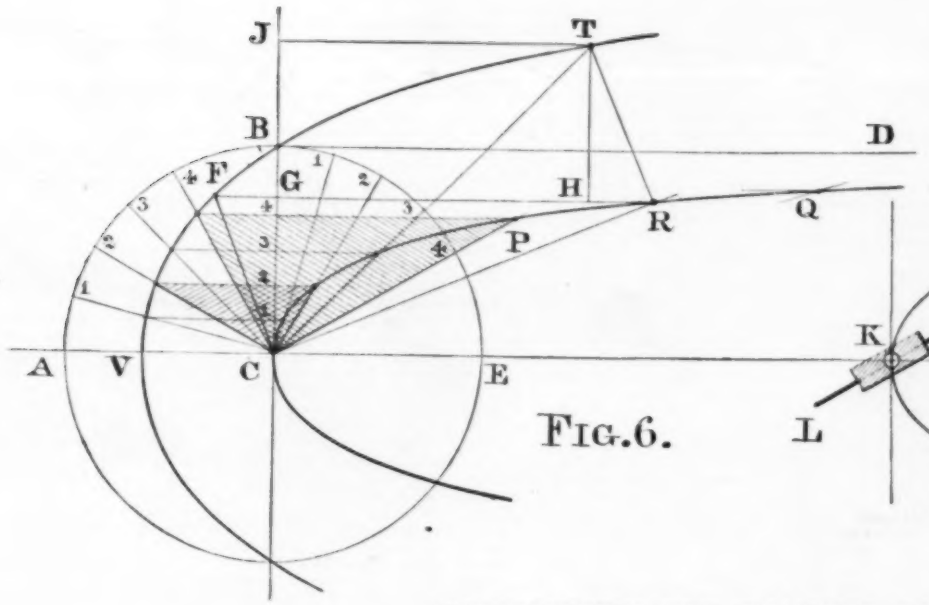


FIG. 6.

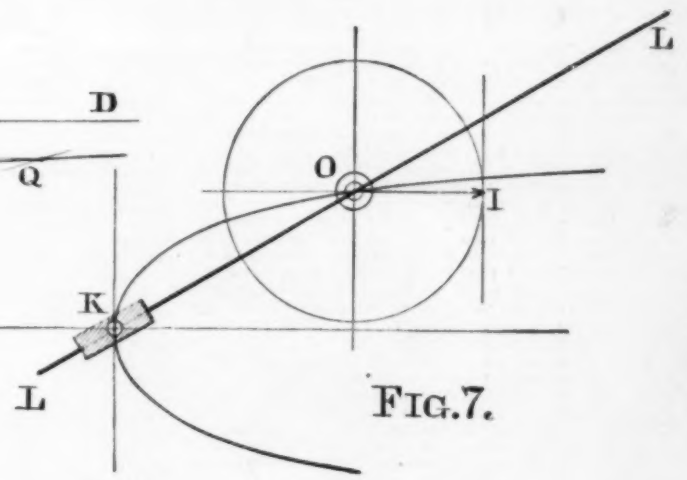


FIG. 7.

INSTRUMENTS FOR DRAWING CURVES.

The color of the resin becomes darker after each exudation of the tree, until it finally becomes almost black, yielding little oil and decreasing in value a great deal.

For many years North and South Carolina furnished the above products; but of late years Georgia and some of the Gulf States have been yielding a great deal.

Of recent years there has been a suspicion that oil of turpentine is adulterated with petroleum, and to determine this the author submitted to test a dozen samples, eight of which were "commercial," three obtained direct from manufacturers, and one was distilled by himself. The specific gravity of the commercial specimens under normal conditions varied from 0·856 to 0·873, the average being 0·860, whereas the specimen distilled by the author was 0·869, and the average of the three obtained from the manufacturers was 0·871. The initial boiling point of the last named specimens was 156°–157° C., and the final 165°–167° C., whereas the commercial specimens varied from 155° C., to begin with, up to 165°–170° C. at the end. The polarimetric results before and after distillation were far from being uniform, as may be judged from the fact that the manufacturers' oils gave 3·85, 9·45, and 16·20 before distillation, while the commercial specimens gave from 2·60 and 14·45 up to 36·64, the rotation in all cases being to the right. These results do not give us a satisfactory specimen, the instrument would require to be modified in a manner indicated in skeleton, in Fig. 7; the controlling lever L L must be extended on both sides of the center O of the wheel, and the block and pivot K must be so far elevated as to permit the wheel to pass under them. This, clearly, presents no mechanical difficulty, and the nature of the movement by which the delineation of the quadratrix can be effected is in no respect affected by this modification. In conclusion it may be remarked that one of the objects of Dinostratus in the construction of his quadratrix was to effect the trisection of an angle: and that, as might be inferred from the substantial identity of the laws of generation of the two curves, this can also be accomplished by means of the subquadratrix.

HOW TURPENTINE IS COLLECTED AND MANUFACTURED.

MR. R. G. DUNWOODY, Ph.G., of the chemical laboratory of the Philadelphia College of Pharmacy, gives, in the *American Journal of Pharmacy*, an interesting account of the collection of the oleoresin of *Pinus palustris*, which is indigenous to the Southern States, from Virginia to the Gulf of Mexico. For the purpose of collection, boxes, as they are called by the manufacturers, are cut into the trees from the first of December until the middle of March; usually from one to four are cut in each tree, according to its size. The boxes are made twelve inches above the ground, so that the lower lip is five inches and the arched upper lip eight to ten inches above the bottom of the box, extending into the tree a short distance; they usually hold from half to one gallon. The tree is then left from two to three days, when the bark is removed about three to four or sometimes ten feet above the boxes, and the tree is scraped or hacked triangularly. The instrument used for scraping is made of iron, the shape of the letter L, with a ball attached to the long arm, the operator taking hold just above the ball, the weight of which aids in scraping.

The oleoresin begins to run about the first of March, and flows best during June, July, and August, decreasing as soon as cool weather begins to approach. The trees have to be slightly scraped about every ten to fifteen days to remove the oleoresin which has become solidified, preventing the flow.

Boxes are dipped every eight or ten days with a peculiarly constructed instrument called a *turpentine dipper*. The oleoresin is first put in buckets and then transferred to barrels on the wagon, their heads being removed until filled, when they are wedged on tightly; the barrels are then carried to the place of distillation.

A still made of copper is set into a brick furnace, which is from ten to fifteen feet in length, five or six feet in width, and about eight feet in height. The still usually holds between fifteen and twenty barrels of the "crude." With the "crude" a little water is added, then the still is warmed so as to make the chips and straw rise to the surface to be skimmed off; a little more water is now added and the top luted on and connected with a large condensing worm placed in a large tank kept filled with cold water. When all the joints have been made tight, heat is applied strongly; the water, having a lower boiling point than the oil, begins to come over first, bringing over a small quantity of oil, which is gradually increased, and is condensed and run into a barrel previously placed at the end of the condensing worm. Water has to be added during distillation to aid the oil in coming over, also to keep the mass from becoming too thick and charring. Some manufacturers distill the "crude" without any water, only what is dipped up with the "crude," but there is danger in burning the residue.

In the receiving barrel the oil, having a lighter specific gravity, floats on top of the water and is dipped off. This constitutes the commercial spirits of turpentine. The residue in the still, after all of the water and oil has stopped coming over, is resin, which is run out through a faucet at the side of the still, having three strainers attached to it, into a long trough communicating with barrels, which hold between three and four hundred pounds. This constitutes the commercial *resin*.

The first exudation of the tree is the best, and is distinguished by the name *virgin dip*, the resin being of a light amber color, transparent, brittle, and melting at 75° C. Resin which is translucent contains too much oil, and is very brittle.

The color of the resin becomes darker after each exudation of the tree, until it finally becomes almost black, yielding little oil and decreasing in value a great deal.

For many years North and South Carolina furnished the above products; but of late years Georgia and some of the Gulf States have been yielding a great deal.

Of recent years there has been a suspicion that oil of turpentine is adulterated with petroleum, and to determine this the author submitted to test a dozen samples, eight of which were "commercial," three obtained direct from manufacturers, and one was distilled by himself. The specific gravity of the commercial specimens under normal conditions varied from 0·856 to 0·873, the average being 0·860, whereas the specimen distilled by the author was 0·869, and the average of the three obtained from the manufacturers was 0·871. The initial boiling point of the last named specimens was 156°–157° C., and the final 165°–167° C., whereas the commercial specimens varied from 155° C., to begin with, up to 165°–170° C. at the end. The polarimetric results before and after distillation were far from being uniform, as may be judged from the fact that the manufacturers' oils gave 3·85, 9·45, and 16·20 before distillation, while the commercial specimens gave from 2·60 and 14·45 up to 36·64, the rotation in all cases being to the right. These results do not give us a satisfactory basis for the detection of petroleum, but it will be seen that any turpentine having a less specific gravity at 15° C. than 0·865 may be looked upon with suspicion. It is also obvious that the boiling points given by the British Pharmacopœia (*initial* 160° C., *final* 180° C.) would exclude the oil of turpentine derived from *Pinus palustris*.

Mr. A. H. Allen, in the second volume of his "Commercial Organic Analysis," states that the following test is of value in the detecting of petroleum:

Three volumes of turpentine oil with one volume of castor oil will produce a homogeneous mixture, while with petroleum the liquid separates into two layers nearly equal in volume. On trying a mixture made of different proportions of petroleum (sp. gr. 0·780, boiling between 150° and 160° C., known as head light oil), Mr. Dunwoody found that as much as 65 per cent. of petroleum could be mixed without detecting it by this test.

But he found that glacial acetic acid sufficed to detect the adulteration, and mixtures of petroleum and turpentine oil in different proportions were found to require different amounts of the above acid for making a clear solution, as follows:

Petroleum	1	2	3	4	5	7	8	c. c.
Turpentine oil	9	8	7	6	5	3	2	"
Glacial acid	40	60	80	110	150	230	270	"

These factors should form the basis for the detection of adulteration.

Mr. W. M. Burton, of Cleveland, gives the following

method for the estimation of petroleum in turpentine. The method is based upon the fact that petroleum is only slightly affected by fuming nitric acid in the cold, whereas turpentine is readily oxidized to various acids of the fatty and aromatic series, which are soluble in hot water. A balloon flask of 750 c. c. capacity is fitted with a two-hole cork stopper. Through one hole is inserted the tube of a glass stoppered drop funnel having a capacity of 100 c. c. The flask is also connected with an inverted condenser. About 300 c. c of nitric acid of sp. gr. 1·400 is placed in the flask, and 100 c. c. of the turpentine to be tested is measured into the drop funnel. The flask is surrounded by cold water, and the turpentine is allowed to drop slowly into the nitric acid. As each drop strikes the acid violent action takes place, with evolution of red fumes.

It is well to shake the flask occasionally during the operation. When the turpentine has all passed into the flask, the apparatus is allowed to stand until all action is over. The contents of the flask are transferred to a large separating funnel and treated with successive portions of hot water. In this way all the products resulting from the action of the acid on the terpenes are removed, while any petroleum paraffins remain insoluble in water, and can readily be separated and measured. The result gives the percentage of petroleum, but is about a unit lower than the truth.

OTTO OF ROSE.*

THE most important center of the production of otto of rose is in the region of the Balkan mountains, and includes about 150 villages situated in the two valleys of Toundja and Strema, affluents of the river Maritza. These two valleys run from west to east and lie between the Great Balkin chain on the north and the Svedna Gora mountains on the south, the extreme points where rose culture is carried on being Koprivchitza on the west and Twarditza on the east. The best otto is obtained on the southern slope of the Balkans. Here the climate is temperate, but the variations in temperature are sudden and frequent. The ground is sandy and porous as a rule; where this is not the case, and water accumulates, roses are killed by the frost, or by fungi which attack the roots. Although the rose cultivation extends over a large tract of country, it is nowhere conducted on a large scale by any one individual, but is divided into a large number of small plots belonging to small proprietors. The dealers live in the towns, and although they sometimes buy the flowers and distill the oil, they rarely cultivate the roses, and then only to a small extent.

The roses are grown in long borders or plots 100 or 200 meters long, the plants attaining the height of a man. Between the plots a space of 1½ to 2 meters is left, so as to allow of a cart passing along between them.

Two roses are usually cultivated, a red and a white one, specimens of which, received from M. Christoff, and gathered in the Kejanlik plantations, have been identified by Dr. Blondel. The red one proves to be a branching form of *Rosa damascena* and the white one *Rosa alba*. One other rose, known as the Constantinople rose, is sometimes met with near Kejanlik. It grows more quickly but is less hardy, and cannot be made a special cultivation. It has larger and more coriaceous leaflets and the flower is smaller than that of *R. damascena*, and of a dark, nearly violet color, like *R. Gallica*; it probably belongs to the same group as the latter, but has not yet been identified.

The *Rosa alba* is employed to form a dividing line between the different plantations, and is also grown at the end of each plot, so as to present only roses of less value to the peasant, who would otherwise steal the more valuable red rose; it is not used, as a rule, for distillation. Dishonest cultivators, however, take advantage of the fact that when distilled it yields a product rich in stearoptene (although of poor fragrance), to mix it with the red rose, and thus obtain an otto which will bear dilution with Turkish oil of geranium (oil of *Andropogon Schœnanthus*, L.)

The plantations are renewed where required in October or November by making trenches about ½ foot deep and one wide, and laying side by side in them suckers with a portion of the underground stem attached. About four or five are placed in a row, the leaves and all being covered with a layer of earth and then with a thin layer of manure. The young shoots make their appearance in five or six months. In April and June the furrows containing the young plants are weeded. In November the remainder of the earth is returned to the trenches, and the trenches are ultimately formed into ridges, to better protect the roots of the plants.

In May of the second year the rose trees are about 2 feet high and yield sufficient flowers to pay the expense of their cultivation up to that date. The next year they are in full bearing, and the maximum product is obtained when they are five years old, although the plants will live more than twenty years. At ten years of age they are, however, usually cut level with the ground, new branches, and even flowers, appearing the next year. The flowers commence to expand between May 20 and 28, and they are collected daily till June 15 and 20. The collection commences every day at dawn, for an opening flower bud, left till next day, will then have lost its fragrance and its color. The flowers are collected by women, and although the small proprietors usually collect their own, the larger growers pay about 2 centimes per kilo for collecting the flowers. The blossoms are placed in a basket carried on the left arm or in the apron. The fingers become gradually hardened to the spines, so that the pricking ceases to be felt, but the fingers become covered with a blackish resinous substance which has a terebinthinous odor, and which at the end of the day is scraped off, rolled into little balls, and kept for smoking in cigarettes, inserted in the tobacco, to which it is said to give a delicious odor. The contents of the baskets are weighed in the field, paid for and emptied into sacks, which are carried at once to the distillery. If the white roses are present in too large proportion, they are paid for separately at a lower price. The stills are usually placed in sheds near the river, for the convenience of obtaining a good supply of water, and in some cases are let by the proprietors at the rate of 4 francs per still. The stills are of copper, and are made to contain 75 liters of water and 10 kilos of flowers. The latter are introduced by means of an osier basket, and the stills are heated with long logs of wood lighted at one end, placed under the still. After a time, if steam comes out of the refrigerating tube, the fire is moderated, and when 10 kilos (two flasks) of rose water have distilled over, the fire is removed by withdrawing the burning logs. The still when cool is opened, the contents strained through the osier basket, and the water remaining in the stills saved for the next distillation. If the operation is continued until 15 kilos of rose water is obtained, the otto is of inferior quality, and contains more stearoptene.

The rose water is then submitted to distillation a second time, 40 liters being distilled at a time, and only 5 liters collected. The vessels in which it is received have the shape of a long-necked flask, and the water is at first milky, like an emulsion, the oil floating after a time in the neck of the flask. It is removed by inserting a conical tin funnel about 2 centimeters long, furnished with a slender handle, and having a capillary orifice. It is dipped below the surface of the otto, and when a drop of oil on raising the funnel appears at the orifice, it is emptied quickly into a special flask.

About 3,000 kilos of flowers are calculated to yield a kilo of otto, and this quantity of flowers is the usual yield per hectare, so that it may be considered that a hectare of roses yields a kilo of otto. The adulteration of the otto takes place chiefly by the addition of oil of rose geranium (*Andropogon Schœnanthus*), whereby the congealing point is lowered from 15° or 16° Reaumur to 14°, 13° or 12° and even lower. The purchaser of otto generally brings with him a basin and thermometer, and having obtained the desired temperature by mixing warm and cold water, and testing the temperature with the thermometer, inserts a flask containing 15 grammes of the essence to be tested. In about three minutes crystalline needles appear, and in ten minutes the otto is solid enough for the uncorked flask to be reversed without spilling a drop. The price varies according to the degree or congealing point, that below 12° R. being openly sold at a special rate. The average production of otto of rose in Bulgaria is about 3,000 kilos in good years and 1,500 kilos in bad ones.

The peasants are paid according to the season, at the rate of 0·22 to 0·23 franc per gramme for otto of standard purity. The flattened circular metal bottles in which it is exported contain 400 grammes, 1 kilo, or 2½ kilos, and the price of the pure essence is 800 to 900 francs per kilo, according to the season. The bottles are generally enveloped in felt. When the essence is freshly distilled it has a slight empyreumatic odor, possibly due to the fact that the water in the stills at the end of the day, having served for several distillations, has dissolved vegetable salts and boils at a temperature distinctly above the boiling point of pure distilled water. Otto of rose is also said to be produced in notable quantities in Asia Minor, at Broussa, Bourgas, and elsewhere by emigrants from Roumelia.

In Provence the cultivation of the roses is at the present time a flourishing industry, and the otto prepared in that district is considered superior to the Bulgarian product. It is obtained from *Rosa centifolia* (a specimen of the plant used from Grasse having been determined by Dr. Blondel). This rose flowers there in April and May. Rose water is sometimes distilled from the yellowish tea rose known as safrano, which flowers in autumn and winter, but the water is very inferior, and the otto obtained from it is still more so, and unfit to mix with that of *R. centifolia*.

The cultivation of *Rosa centifolia* is carried on chiefly around Grasse, Cannes, Nice, and Valois, by peasant proprietors, who sell the flowers to the distillers in the towns. The roses are grown in little hedges of 0·75 in. high, separated by paths 1 to 1½ meters wide. The flowers are gathered at the end of April, or about twenty days earlier than in Bulgaria, and the collection lasts twenty to thirty days. The collection commences at dawn, and the collectors, both men and women, are paid at the rate of 0·45 franc per kilogramme, the price in bad seasons rising even to 1¾ francs. The chief use of the roses is for making rose pomade, only a small quantity, comparatively speaking, being distilled for the otto. The flowers are distilled in large stills, such as are generally used for spirit, some holding as much as 150 kilos of flowers. Often one refrigerator receives the condensing pipes of several stills.

Usually 50 kilos of flowers and 300 liters of water are placed in the still at one time, and 100 liters are distilled over, the first 25 being the richest in oil, and known as eau double de rose; the next 30 are of medium and the remaining 45 of inferior quality. The oil which floats is collected by means of a Florentine receiver. The yield of otto is small, 100,000 kilos of flowers giving only a kilo of otto, and the price is about 1,000 francs per liter. The average price of the rose water is 2·60 francs per liter.

In Germany roses have been distilled for about five years in the neighborhood of Liepzic, about six hectares being at present under cultivation. The species employed is *Rosa centifolia*, and the amount produced in 1887 was 3,000 liters of rose water and two kilos of otto. The latter congeals at 20° C., and contains 32½ to 34 per cent. of stearoptene, which is in excess of that in Bulgarian otto. Indeed, the proportion of stearoptene present in otto of rose is always greater in cold countries.

Formerly otto of rose used to be adulterated by mixing it direct with oil of ginger grass, but now the flowers are sprinkled with the oil when placed in the retort. The odors under these circumstances amalgamate better, and during the distillation the proportion of waxy (cireuse) matter that passes over is larger, so that otto thus obtained may solidify at 14°, even when containing 25 per cent. of oil of ginger grass. In this case, however, the otto appears muddy, and does not present the sparkling crystals characteristic of pure otto. The odor also is easily detected by an expert. Bromine turns pure otto of rose of a green color, but is itself decolorized by oil of ginger grass, and if a few drops of liquor potassæ are subsequently added, an apple green precipitate in viscous clots is formed in a colorless liquid, and the odor of roses is not altered. But if adulterated with ginger grass oil, a yellow milky precipitate is obtained in a reddish liquid, and a disagreeable odor is given off. This test, however, is qualitative rather than quantitative.

The presence of spermaceti or paraffin in otto is detected in Bulgaria by rubbing the small test bottle of otto between the hands, containing about 15 grammes, when the essence rapidly liquefies, since a temperature of 18° C. suffices, whereas paraffin does not melt till 32°–50°, and spermaceti at 46° C., and these remain undissolved at the bottom of the bottle.

Experiments made by Dr. Blondel show that pure otto of rose has some physiological effect. In a dose of five or even of two drops it produced cramp of the stomach in the absence of food. Taken after a meal it seemed to stimulate the digestive functions at first, but doses of ten or twelve drops appeared to have an opposite action, and caused marked flatulence. The only general effect noticed was a marked tendency to sleep. A guinea pig into which a cubic centimeter of otto was subcutaneously injected died in four days after a state of profound torpor lasting forty-eight hours. The only effect noticed in a post mortem examination was slight congestion of the meninges. In some persons the odor of the rose produces headache, and in rare cases severe symptoms, which are probably due to idiosyncrasy. The oil of *Andropogon Schœnanthus*, or Turkish oil of geranium, used to adulterate oil of roses, produces similar symptoms, but in a higher degree.

With regard to the portion of the flower in which the otto is formed, observations made under the microscope by Dr. Blondel indicate that it is secreted by the epidermal cells. If a section through a petal is immersed in a ¼ per cent. solution of osmic acid for about twenty seconds, and then washed in distilled water and mounted in glycerine, the upper and lower epidermis are seen to be the parts distinctly blackened. Other experiments show that these cells also contain fixed fatty matter, since, when the petals are distilled until wholly deprived of odor, these epidermal cells are still blackened by osmic acid, and yield to ether a fixed fatty substance. But the fresh petals treated directly with ether, and thus deprived both of fixed oil and essential oil, still show the blackened epidermal cells when treated with osmic acid, but with a bluer tint in them. This is due to tannin, as may be proved on a section of the fresh petal by the use of acetate of iron. When the petals are deprived of their essential oil by distillation, of their tannin by boiling water, and their oil by ether, the epidermal cells no longer become blackened by osmic acid. There is, therefore, every reason to suppose that the chemical changes by which the otto is produced take place in the epidermal cells, or in other words that they are not special receptacles of secretion, but secreting cells. The epidermis of the anther does not contain otto, but it is contained in small quantity in that of the filament and on the stigmatic surface and groove, though not in that of the ovary or style.

* Abstract from *Les Produits Odorants des Rosiers*, Dr. R. Blondel, Paris. 1889. Octave Doin.—*Pharm. Journal.*

REMOVING GREASE FROM AND BLEACHING TEXTILE MATERIALS.

A NEW product, which is the subject of an application for a patent, is principally constituted of a mixture of caustic soda and hydro-sulphide of soda (Na H S) in equal proportions. The caustic soda is replaced by a caustic salt, such as commercial carbonate of soda, containing a certain proportion of caustic soda, and the hydro-sulphide of soda by monosulphide of sodium, prepared by dry means. These substances, of which the proportions can be varied to a considerable extent, are dissolved either separately or together; they are, if necessary, clarified, by decanting or by filtration. The liquid thus obtained can be employed, either pure or mixed, according to the applications to which it may be put. When it is desired to obtain the product in a solid state, for the purpose of commerce, 100 parts in weight of the alkaline liquor before mentioned are, as a rule, used, but containing by preference 70 parts, or thereabout, of soda or caustic salt, and 30 parts, or thereabout, of hydro-sulphide of soda or of monosulphide of sodium. This alkaline sulphureted product is crystallized, by mixing it cold with an equal weight of carbonate of soda at about 90°. The crystallization takes place after a few hours. The proportion of carbonate of soda may reach, sometimes, 140 per cent. of the weight of the liquor, if it is desired to obtain harder crystals and a more rapid crystallization. The product can be used with advantage for the removal of grease, and for the washing and lixiviating of any description of textile materials. For all operations, it is sufficient in principle to prepare a bath containing a convenient proportion of the product, according to the effects to be obtained. This bath is employed hot or cold, as the case may be, and, if it is desired to obtain more bleaching, a small quantity of sulphurous acid is added in the liquid, as a decolorizer, during or after each operation. Or equivalently, the objects may be passed into another bath containing ordinary water acidulated with sulphurous acid. The following are instances of the process which it may be necessary to follow for the application of the product in the various operations. Washing and lixiviating linen: In 100 kilogrammes of pure water is dissolved 1·500 kilogrammes of the composition of sulphureted alkali. The linen is immersed by folds into this mixture in proportion to the size of the bucking tub. It is then allowed to macerate two or three hours cold. It is afterward heated to a sufficient temperature for about two hours, and then allowed to settle, and is afterward washed and rinsed in water in the usual manner. According to the degree of whiteness that it is desired to obtain, a variable proportion of sulphurous acid is added, either in the bucking tub or in a special bath, in which the linen is soaked before rinsing. Treatment of the ramie: The fibers are first soaked cold in a bath composed of 100 kilogrammes of ordinary water and two or three kilogrammes of the sulphureted alkaline composition, the quantity being augmented or diminished according to requirement. It is then made to undergo boiling, during which the fibers of the ramie are put into motion by any mechanical means, and afterward the various rinsings are proceeded with in ordinary water. For the other textile materials, the operation differs little, as, in each of these operations, the alkaline solution is more or less sulphureted according to requirement. It is the same for the removal of grease from wools and the fulling of woolen yarn and woolen cloth—a quantity of 1·500 kilogrammes to 2·500 kilogrammes of the sulphureted alkaline composition to 100 liters of water is sufficient to effect a perfect removal of the grease. A quantity of about 2·500 kilogrammes of sulphureted alkali, dissolved in 100 liters of water, in employed in these operations of fulling and removing of grease from

cloths, woolen yarn, and woolen cloth. This new product does not dispense with the employment of olein, in mixture therewith, in the different operations of fulling and removing of grease from wools and woolen cloth. The cloths retain all their softness, the removal of the grease is complete, and the colors are brightened to a very sensible degree. The application of the product is, moreover, economical, as it accelerates the fulling, and only requires 50 per cent. in comparison with the products in use at present. The patentee does not limit himself solely to the proportions indicated, as the proportion of the composition may be varied according to the effect to be produced. Thus, as the case may be, the proportion of sulphureted alkali to be employed may vary from 1 to 50 per cent. in weight.

WATER SOFTENING APPARATUS FOR STEAM BOILER FEED.

WE illustrate the arrangement of water softening apparatus erected on Maignen's system at the Cornwall works of Messrs. Tangye, Birmingham, and similar to that erected at the London and Southwestern Railway Company's works at Nine Elms, where the apparatus supplies softened feed water for a large battery of fixed boilers of the locomotive type. The plant shown is capable of softening and clarifying a minimum of 500 gallons per hour. The water to be treated is generally about 36 deg. of hardness, and contains, apart from the lime, etc., in solution, large quantities of earthy substance in suspension. After treatment the hardness is reduced to six deg. or seven deg., and is brilliant and free from any suspended matter.

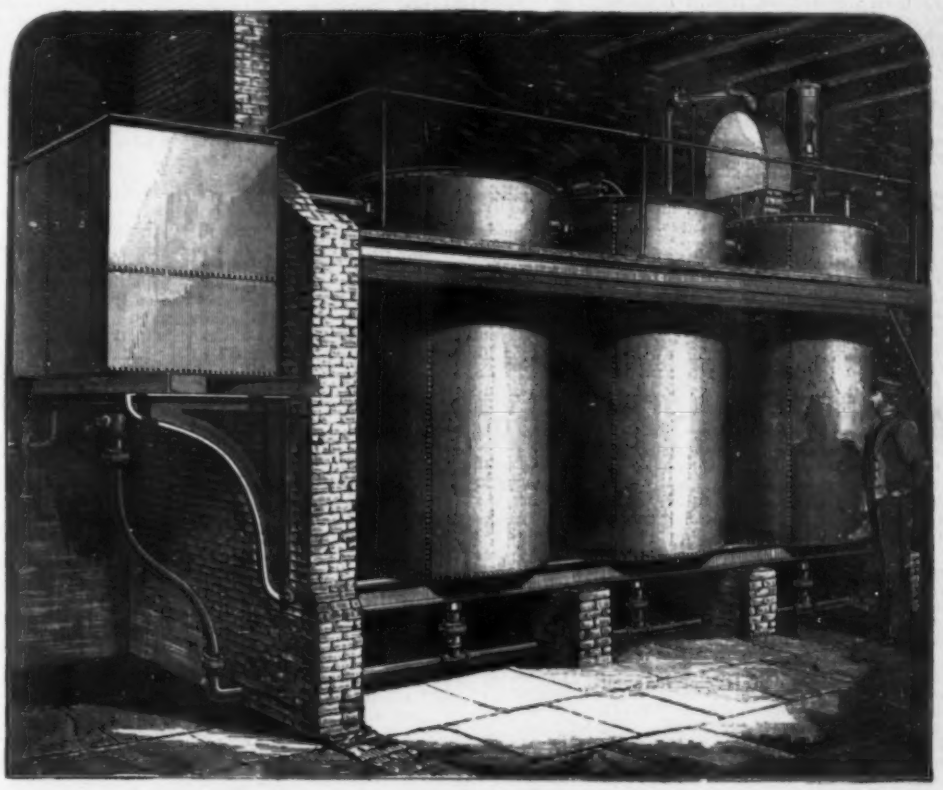
The plant consists of three cylindrical cisterns of an aggregate capacity of 1,300 gallons. An iron cone is loosely dropped into each cistern, and the connections between the tanks are made in such a manner as to guide the water in an up and down direction. This arrangement, apart from its facilitating the mixing operation, assists the precipitation of the solid matter.

On the top of the first tank is placed an automatic reagent feeding apparatus similar in action to a pug mill, and arranged so that it gives a definite proportion of reagent to water. The hard water to be treated enters so that it passes over a waterwheel as shown in the engravings. The motion given to this wheel is communicated to a feed wheel inside a hopper, which contains the reagent and sends out a definitely proportioned quantity through a small slot. This slot can be minutely regulated so as to soften the water to the desired degree.

In order to bring the water and the reagent into intimate contact with each other, the water is made to pass through 2 in. orifices at the apex of the two cones in the first and second or mixing tanks. By the time the water has reached the outlet of the second tank the chemical action is complete and clarification commences, and in order to hasten this operation a series of inverted wrought iron funnels is placed in the third cone.

Each funnel has an India rubber ring round the outer edge, to form a tight joint between the edge of the cones, so that no water can rise to the top of the tank without having taken an in and out course through the series of funnels. The effect of this arrangement is to precipitate the solids inside and on the surface of the funnels, and on the flat plates between them. By the time the water reaches the top of the third tank it is comparatively clear, but not sufficiently so for feeding steam boilers.

It therefore has its final clarification through a large

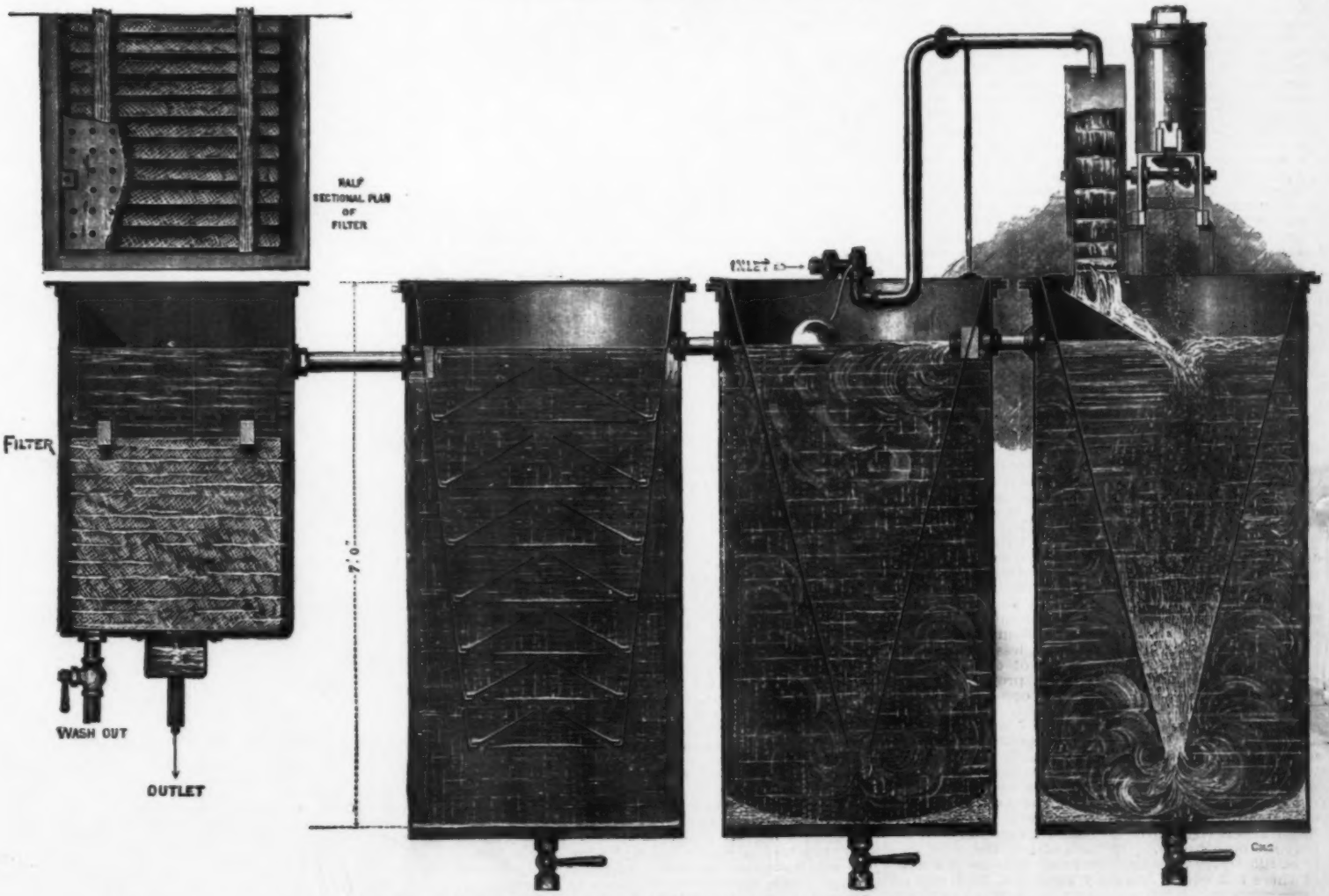


IMPROVED WATER SOFTENING APPARATUS.

form of Maignen's "Filter Rapide." This consists of a series of hollow wood frames stretched over with pure asbestos cloth. A rubber ring is fixed on the outlet of each frame, forming a tight joint between the body of the filter and a false bottom which receives the softened and filtered water. The frames are all held firm by a couple of racks and thumbscrews. The method of cleansing the apparatus is very simple. Each tank is fitted with a blow-off cock at the bottom, and the deposit on the filter frames is removed by passing a hose between them. The tanks and the filter are cleared of their solid contents about once a month or six weeks, and the asbestos cloths are readily accessible and renewable. The material being indestructible, they never need renewal if fairly treated.

The mixture of reagents employed is that known as "Anticalcaire." It is varied according to the requirements of the water as found by analysis in each case, so as to remove the required proportion of the permanent and temporary hardness. This mixture costs, we are informed, about 1d. per 1,000 gallons softened for say Thames water.

The apparatus, such as that used at Nine Elms, requires no attention, except about once per day to fill the reagent hopper, and, of course, once a month or so to clear out sediment. Mr. W. Adams, M.I.C.E., locomotive superintendent of the line, says the steaming qualities of the boilers have been increased since using the softening apparatus, and they are free from incrustation.—*The Engineer.*



IMPROVED WATER SOFTENING APPARATUS

COLOR AND COLORING.*

By Prof. A. H. CHURCH, M.A., F.R.S.

LECTURE III.

Distribution and Balance of Color.—When the constituents of a set of colors to be associated together have been decided on, it still remains to determine their sequence and the relative areas they shall occupy. Such triads as were given in the last lecture may be made disagreeable or pleasant by altering their distribution or their proportions. The triad *red, gold, blue* affords as good an illustration of this fact as we could wish. If we make the red and blue come into contact throughout the design in equal areas, and if we then spread over the surface a spray of gold foliage in such a way as to employ, in masses of considerable extent, just as much gold as red and as blue, the result will be crude and unsatisfactory. But we may develop the varied beauties of which this group is susceptible by modifying the arrangement and proportions of its constituents in scores of different ways. Let us devise one such way, of which the plan shall be separation of the blue and red by gold, and the use of these three chromatic elements in the ratio 7 : 3 : 1; so we make our blue ground cover seven-elevenths of the area to be decorated; our arabesque and its curves, or our spray and its foliage, will be of red, three-elevenths, bordered throughout with gold, one-eleventh. I need not tell you how much we may modify and improve the result by the beautiful curves of our spray, and by half entangling patches of the ground within its borders. And this end may be reached by many other methods which I cannot stay to describe.

One of the tetrads named in the last lecture will serve to illustrate these matters of arrangement and proportion. The example is taken from an early Irish illuminated missal. The four elements are silver, gold, red, and black. The proportionate areas are 4 : 4 : 1 : 1. Silver and gold quatrefoils alternate. They are bordered by red in the form of a line of uniform breadth; the residual space is covered with black, but this is broken up into such small portions that it does not look heavy, while the continuous red outline serves at once to bind the whole design together, and to prevent too strong a contrast of tone between the black and the gold or silver. You will be able to think of many an arrangement of these four elements which would prove less felicitous, and, doubtless, of others equally good.

I have before spoken of the principle of the "dominant hue." It will be easy to carry out this principle by modifying the area of the elements in our triads. In this way one of our "cold" triads—such as bluish green, violet, red ocher, may be made "warm." In such a case we shall have to increase greatly the area occupied by the red ocher and to proportionately diminish that of the other two elements of the group. We may, for instance, prepare a large design of foliage of red ocher upon a ground of bluish green, separating these two colors by a contour line of violet, adding perhaps some fine veins of violet to our large leaves. But it must be noted that such arrangements often become easier and more pleasing when we are at liberty to introduce a fourth element, even if that element be but white or other neutral. A fine old Rhodian tile in my collection affords a case in point. It has a ground of a red ocher hue occupying five-tenths of the whole area. Upon this a design of white foliage, highly conventionalized, spreads in a connected and symmetrical fashion, and covers three-tenths of the surface. The remaining two-tenths are shared between a full blue and a slightly bluish green in nearly equal proportions. These colors are distributed upon the white portions of the design chiefly in the form of veinings. There is also a fifth but inconspicuous element in the chromatic scheme, namely, a delicate contour line of deep gray. The effect of the whole arrangement depends upon the dominant red hue of the ground, but this is refined and lightened by the net of white foliage, which, in its turn, gives strength and purity to the gracefully curved forms of blue and of green which it incloses. The uses of color schemes in which a dominant hue is present are frequently of the utmost importance in hangings, papers, and wall decorations. These have to perform the office of a background, and to set off one or more conspicuous chromatic elements in the room. If you want to display properly some fine pieces of blue and white porcelain, your walls must not be so colored as to interfere with their effect, but rather to enhance it both as to tone and hue. A flat buff or gray may make your porcelain too conspicuous; a bright blue and a pure white will clash with it; a strong red will overpower it. A scheme of coloration which in its totality produces the effect of a grayish olive green, half way in depth of tone between the white and the blue of your vases, will probably be found to answer well.

When it is not desired to direct attention specially to the colors of the objects in a room, then it is allowable to gather into certain parts of your wall decoration the more telling of the chromatic elements which enter into its composition. You accentuate the design by focusing the more saturated and luminous colors in the more important parts of the design.

From what I have stated thus far, I think it will be evident that, even if we could attain such a chromatic balance as would produce a true "neutralized bloom" on our walls, or in the carpets on our floors, we should still have left out of our scheme the more important chromatic elements belonging to our movable furniture and ornaments. In fact, the system of contrasts of hue and tone—contrasts more or less subdued—is the only one by which a real unity of effect can be reached; at the same time that due prominence and relief are secured for those parts or objects where prominence and relief are needed.

Returning once more to our triads, I would mention a principle of arrangement often adopted with success, namely, the separation of two nearly related tones by a tone which is darker or lighter. Sometimes this sequence brings together chromatic elements which clash, and, of course, it must then be avoided. Still, the rivalry of two colors having the same degree of brightness is frequently unpleasant, especially where they are both strong. The triad of full red, gold, full blue, illustrates these observations. The use of a triad of three full colors is rarely successful, and can no more be tolerated than the presence of three trees of equal size and equal prominence in a landscape picture. Where three colors having three decidedly different tones are used in one scheme, we are almost compelled to arrange them in the order of their depth—dark, medium, light.

You will, I think, excuse the elementary and fragmentary character of all these remarks of mine on distribution and balance of color; no one can be more conscious of their imperfection and of their commonplace character than I am.

Counterchange and Interchange.—In heraldic coloring the principle of counterchange is frequently adopted. Ermine is white spotted with black; counter-ermine, black spotted with white. Suppose a shield of arms divided diagonally from right to left, and bearing a star. Where the field is azure the star is argent, where the field is argent the other half of the star is azure. In the latter half of the eighteenth century the same arrangement was adopted in textiles and embroideries, great skill being shown in the passage from a design say of red upon a blue ground to the same design in blue upon a red ground. I have noticed that in the more successful of these counterchanged patterns the areas occupied by the pattern and the ground are about equal. When these designs were executed in "cut" work there was no loss of material, for the pattern cut out from one part of the design formed the ground of the next. In the cut cloth work of Resht in Persia, a similar mechanical method of procedure was adopted, but the counterchanges were not effected in the same piece.

The principle of interchange may be illustrated by the alteration of a set of tones of greenish yellow with a corresponding set of tones of violet. These tones may be so arranged that the series begins with the deepest tone of each color alternated, the rest following in regular sequence, or the deepest tone of one color may be followed by the lightest tone of the other, and so on; but a satisfactory effect is difficult of attainment.

Colors of Minerals.—I have time to refer to a very few only of the characteristics of colored minerals. The colors of some of the most beautiful precious stones are in a measure dependent upon the phenomena of dichroism which they exhibit. The ruby, sapphire, emerald, and tourmaline may be named in this connection. Quite apart from the prismatic decomposition of light which these gems effect when faceted, they show, with more or less distinctiveness, the twin colors of dichroic bodies. The ruby exhibits in the same stone a pure red and a crimson or carmine red; the sapphire, a straw yellow and a pure blue; the emerald, a bluish green and a pure green; and the tourmaline, broken tints of yellowish green and reddish brown. No monochroic substance, such as paste, enamel, or glass, can give rise to the variable fluctuations of color seen in these dichroic gems. The peculiar chatoyancy of Labrador spar has also not yet been imitated in any artificial material. The beauty of lapis-lazuli and of many agates and jaspers is, no doubt, partly dependent upon the pulsing of the colors they exhibit, partly upon a certain measure of translucency which they possess. This quality of translucency is also seen in many marbles, especially when they are polished; its absence from some artificial materials (such as terra-cotta) is perhaps one of the reasons why it is difficult to associate the two classes of materials together with satisfactory effect. When both are in small pieces, and especially when they all receive together the same polish, the incongruity in question does not attract notice. The tesselated Roman pavements found in this country often afford excellent illustrations of this harmonizing of natural with artificial materials—marble and stone with pottery, and even glass.

The picturesque colored markings and veinings of many marbles are best developed by polishing, and best seen in surfaces of considerable size. If these surfaces are not plane, their curvature should not be complicated with flutings or other sculptured treatment. A carved ornament in such marble is a mistake, at least when the colored markings are decided. Man's art in relief spoils nature's decoration in color. For this reason the carved work in Derbyshire alabaster, for which the late Sir Gilbert Scott showed so much partiality (witness many a reredos which he designed) is most unsatisfactory. Over and over again a dark veining makes a prominent part of the carving appear to recede, while a bright and pale patch throws a hollow or recessed detail into conspicuous relief.

Colors of Animals.—The most brilliantly colored of animals—birds—naturally attract our attention. I do not pretend to champion all the chromatic arrangements of nature. Yet two circumstances must be taken into account in considering the colors of animals and plants. These colors and color associations must not be considered apart from their natural *entourage* and the conditions of their existence. And, secondly, if we are to follow the leadings of evolutionists, it cannot be maintained that the coloration of plants and animals in a state of nature is connected with the chromatic tastes of man. Of course, under domestication, the hues of both are greatly modified by processes of artificial selection and of treatment.

Let me direct your attention to the colors of certain humming birds as typical examples of peculiarly powerful colors, many of them belonging, in the intensity of their regular refraction of light, to the metallic group, but being more strongly colored. One of these is a Central American species, and is known as the "garnet" (*Lamprolæma Rhami*). It is commonly spoken of as showing a brilliant patch of garnet red upon its throat and breast. But in reality this hue is not invariable and uniform. In the constant movements of the living bird it must be ever changing with its changes of position. As you examine a mounted specimen you will see at first only a metallic crimson, but when your view point is altered, all the passage tints between a rose madder and a greenish yellow follow in their regular spectral sequence. This sequence, which will be observed, I believe, in all similar cases, is connected with the mode of production of these metallic colors. They do not arise directly from the presence of actual coloring matters or pigments, but from the minute optical structure of the web. Another humming bird, a "train bearer" (*Cynanthus forficatus*), has its conspicuous tail feathers adorned with metallic violet, but this violet passes in some positions and in some parts into a splendid greenish blue, every intermediate tint being present. So with one of the "comets" (*Sappho sparganurus*), the tail feathers sparkle with a golden bronze, ranging from orange to red orange. Another "comet" (*Sappho phaon*) is similarly decorated, but the colors range from madder red to red purple. Another bird, the "ruby and topaz" (*Chrysolampis mosquitus*), has on its head a patch of metallic crimson, passing into orange when viewed from some positions; similarly, the fiery metallic range of its breast passes into yellowish green in some portions.

I cannot refrain from citing the case of another humming bird, one of the "sapphires" (*Eucephala cærulea*). Here the head is decorated with a color not of the metallic order, but still very rich, almost the color of French ultramarine blue. But on the breast of this bird a metallic color reappears; it is a fine blue, passing into an equally fine green. I have said nothing of the brownish black background which shows off all these splendid hues, because I want you to notice more particularly that these dazzling metallic colors are never really uniform and flat, even though their tones may be equivalent, for they show large ranges of hue, not capricious, but following the orderly sequence of wave lengths in the spectrum. I must omit all reference to the coloring of butterflies and shells, about which I had much to say, in order to pass on to the vegetable kingdom.

Colors of Plants.—The texture and translucency of flowers and leaves greatly modify the hues of the coloring matter they contain and of the light which they reflect. The peculiar glistening of the cell walls in the colored tissues of flowers is a case in point; it is sometimes erroneously spoken of as crystalline. The distribution of the various coloring matters of flowers in cells, when the colored tissues are examined under the microscope, is seen to be much less regular than might be imagined, and is doubtless one of the causes of the peculiar chromatic beauty of many flowers. In speaking of the colors of plants, some reference must be made to the green of foliage. If the fully developed leaves of a forest tree in summer sometimes tend toward a certain heaviness and monotony of hue, still there is, even in this case, a degree of variety present. Some leaves are in shadow, some transmit the incident light, some reflect the blue of the sky or the gray of clouds, some display in perfection their local color, and some show in different parts the various hues just indicated. And then, too, it must not be forgotten that the green color of foliage varies with its age, and that it always possesses a singular characteristic which distinguishes it from other greens, for if we place a spray of green leaves upon a piece of green cloth or of green paper resembling it in general hue, we shall yet find that the natural pigment differs materially from the artificial in its chromatic constituents. To prove this you need not have recourse to prismatic analysis; you have only to illuminate both surfaces with red light, or to inspect both through a piece of red glass, to see a very striking difference, especially noticeable with the yellowish green foliage of young branches.

I regret that time fails me, or I should have liked to direct your attention to the colors and textures of wood, and of various vegetable fibers.

Colors of Artificial Materials and of Fabrics.—I have already named glass as affording illustrations of the throbbing or vibrating of color. In the examples of colored glass which I now show you by means of the electric lantern, we may observe the various causes which conspire to produce the artistic charm of really beautiful glass. They include not merely fluctuations in hue and tone, but the presence of bubbles and blebs, of striæ, and of solid and comparatively opaque particles. All these things serve to prevent the direct emergence of uniformly colored beams of light from the material. I have mounted some of these specimens of glass in pairs, putting side by side, for instance, a piece of builders' blue glass and a piece of the beautiful blue glass made by Messrs. Rust & Co., of 353 Battersea park road, S. W., to whom, indeed, I am indebted for a series of choice specimens, illustrating the poetry of colored glass as distinguished from its ordinary prose. In this connection, it is interesting to observe that the good old stained glass, like these fine samples of Messrs. Rust & Co.'s manufacture, is immediately discriminated from the commonplace kinds in a strong light. When the sun or the electric light shines through the former it becomes itself illuminated, but throws no definite colored images upon a white screen suitably placed; while the optically perfect but wholly uninteresting flat colored modern glass reproduces by transmission its chromatic design. By this test the modern "restorations" in an ancient window may frequently be recognized.

I have no time to tell of the colors of other artificial products, of enamels and of porcelain, for example. But I cannot refrain from directing your attention to the colors and patinas of certain metallic alloys. The Japanese are masters in this particular line. Their *shibuichi*, or gray bronze, consisting of copper alloyed with considerable but varying proportions of silver, gives a series of yellowish grays; their *shakudo*, copper containing a small percentage of gold, when heated in suitable pickling baths, is susceptible of receiving a blackish patina, sometimes violet black, sometimes bluish black. Their bronzes, into which lead and antimony, as well as tin, often enter, frequently present very beautiful effects of color upon their surface. But perhaps the "red copper" of the Japanese metal worker is as beautiful as any alloy. It is pure copper, the surface of which has become coated with a strongly adherent and coherent film of red suboxide. This film is tough and strong, and varies in color in different specimens from a crimson red to a reddish brown. This patina is often translucent, if not transparent, and shows a fine gloss like that of lacquer. Messrs. Christophle, of Paris, and Messrs. Tiffany, of New York, have achieved a measure of success in their attempts to reproduce some of these beautiful Japanese patinas, but there remains a large field for their employment in artistic metal work, in the form of flat inlays and reliefs.

I cannot do better, in order to illustrate the tone and color effects which may be produced by the association of different textile fibers, than show you in the light of the electric lantern a series of Japanese brocades and of Persian embroideries. The "shot" silks, the varying sheen produced by the different directions of the threads, and the association of lustrous with comparatively dull materials—all conduce to the beauty of the effects.

* Recent lectures before the Society of Arts, London. From the *Journal* of the Society.

Pictorial and Decorative Art.—It has often been pointed out that color is an end in decorative art, a means in pictorial. This almost amounts to saying that decorative color is without meaning; expresses neither the ideal nor the real. I cannot but think that this view is far from being correct. Let us contrast and compare the coloring of a landscape and that of a decorative fabric. In the picture great use is made of gradation of tone and hue, in order to represent atmosphere, the play of light and shade, and different planes. The artist, moreover, is restrained in his use of full and saturated colors, nor does he attempt to represent all he sees, but makes such a selection of the materials at his disposal as, without violating nature, shall best serve to realize his impression of the scene. Form is with him of equal importance with color, while symmetrical arrangement and repetition of similar elements are never made evidently conspicuous. The designer of a fabric, one, say, for use as a curtain, avoids the use of those contrivances by which the flatness of the surface would be destroyed; gradation of hue and tone, though admissible, plays a quite subordinate part in his work. He is at liberty to use the most saturated and intense colors, provided only he can so employ them as to produce a pleasing harmony, and at the same time be in accord with the nature of his material and the purpose to which his design is to be put. Moreover, the decorator selects, as does the landscape painter, but he rejects much more than he absorbs. To nature he goes for motives, but individualization assumes the last place, generalization the first. Form and color are not with the decorator of equal moment, sometimes the former being paramount, sometimes the latter. Usually the less pronounced his color the more dependence does he place upon his form, although in complex chromatic schemes also he has often to rely greatly upon trenchant contours in order to avoid confusion. The notion that bad or weak drawing is permissible in decorative art ought not to be accepted for one moment. The very fact that the boundaries between two colors in ornamental designs frequently need to be sharply accentuated by means of well defined outlines should suffice to demonstrate the necessity of thorough draughtmanship. And lastly, the decorator makes large and frequent use of symmetrical and repetitive arrangements.

If I am right in this comparison and contrast, then the distinction between decorative and pictorial work is, like many another distinction in the domain of art, one of degree rather than of kind, quantitative rather than qualitative. The same elements are at the disposal of the decorative and of the pictorial artist, but they must be employed in different proportions. And here I am in accord with the view that there are an infinite number of possible transitions between the coloring that is most fully pictorial and picturesque and the coloring that is most purely decorative or conventional. Much, but by no means all, of Japanese decorative work in color illustrates some of these transitional forms.

Color in Relation to Sculpture.—In the very few words on this subject for which I can find time I should wish to draw your attention to these two points, namely, the surroundings of sculpture in relation to its color and the material of sculpture in relation to its color. It seems to me that when sculpture is destined to form an integral part of an architectural scheme, its tone and its hue must not be such as to interfere with the unity of the plan, but rather to enrich and vary it. And it may easily happen that an association of sculpture in marble with an edifice in stone may be harmonious when both marble and stone are fresh, but may in course of time accord less happily, as the latter darkens with age much more considerably than the former. The same effect is produced when a glaring white marble monument is intruded into a building deeply toned with the rich warm gray of centuries. So, on the other hand, a statue in bronze may be too deep in tone to harmonize with new clean-cut stone, but, as years pass, the startling difference between them will abate. The case is different where the building and the sculpture it contains are not intended to fuse into one organic whole. Under such circumstances, the building must be subordinated to, and even contrasted with, its contents; it becomes a background so colored and so arranged as to emphasize the statuary it protects. And in considering the vexed question of the artificial coloring of works in sculpture, it will be well to glance for a moment at the four chief kinds of material out of which such sculpture is generally wrought. These materials are terra cotta, bronze, stone, and white marble. It will be owned that the critical eye accepts without hesitation the refined coloring which the exquisite terra cotta figures from Tanagra still so frequently retain, as well as the varied hues of the patina on statues in bronze. In the latter case we go so far as to dislike what may be called the natural hue of the metal, unless it appears to a limited extent only in such parts of a figure as *might* be supposed to have lost their artificial or altered surface color by a process of attrition. But when we leave artificial materials and pass on to those which are natural, our attitude as to the problem of coloring differs. While there seems to be an innate congruity between artificial materials and artificial coloring, natural materials lend themselves less readily to chromatic treatment. Perhaps there are here two causes at work, one being our satisfaction with and appreciation of the natural beauty of the tones and hues of native substances, the other being the difficulty of bringing our added coloration into harmony with that which is natural. This view is supported by the observation that the addition of color to the rarer and choicer materials, such as statuary marble, is more generally resented than the similar treatment of the commoner and less interesting kinds of stone. But is there not a third and more potent cause? Does not pure white marble, with its slight translucency and its beautiful crystalline texture, lend itself so perfectly to the presentation of ideal forms that even the faintest suggestion of realistic color may look like sacrilege, and may only too easily lapse into vulgarity?

In architecture, too, the poorer and less interesting the material, the more useful does the addition of artificial color become. Yet it may serve on the one hand to emphasize the poverty and weakness of bad contours and mouldings, though, on the other hand, it may be made to accentuate and to ennoble forms which are in themselves beautiful. Its distribution and arrangement are as important as its tone and hue. It may destroy the unity of an architectural scheme, or it may serve to fuse discordant or fragmentary elements into one harmonious whole.

Excuse, ladies and gentlemen, the all too casual and imperfect discourses which I now conclude. Yet I trust my disjointed utterances may not prove to be wholly valueless, for they may serve, if no other end, that of directing your attention and guiding your observation to some of the infinite resources and intricate delights of chromatic combinations. I venture, moreover, to express my confidence that the scientific study of the glorious sheaf of spectral colors which we have been making together will not lead you to agree with the poet Keats when he sang:

"Do not all charms fly
At the mere touch of cold philosophy?
There was an awful rainbow once in heaven:
We know her woof, her texture—she is given
In the dull catalogue of common things."

GRAIN OR NET NEGATIVES FOR PROCESS WORK.

THE first necessity in many of the processes of photo-mechanical printing is a means by which the natural half tone of the negative may be broken up into some sort of grain in the positive print, and this is frequently effected by the use of a film negative interposed between the printing surfaces, or it may be between negative and lens in the process of reproduction. The chief essentials in such grain negatives, beyond a sufficient degree of fineness for the particular purpose or process, are absolute uniformity and perfect clearness of the transparent portions, together with a sufficient degree of density.

With the first of these conditions we have not at present to deal; the particular form of grain is comparatively an unimportant matter, provided it is uniform, and may consist of a series of minute circular dots, a network of crossed lines, or, indeed, of any fine pattern that will conveniently serve the purpose. The best of such negatives are made by reduction in the camera upon collodion films, and it is our intention in the present article to give brief directions which may prove useful to a rapidly growing class of experimenters in photo-mechanical work.

We must assume that a choice has been made of the material from which the grain negative is to be made, and that, whatever it may be, a camera reduction is to be made. This will be found to give the most satisfactory result, as though wire gauze, for instance, is obtainable as fine as 120 holes to the linear inch—as fine as is ever needed—a far more even as well as a cleaner grain is produced by photographing down a coarser material. Such gauze is obtainable in brass or copper of almost any degree of fineness to that just mentioned at most of the dealers in philosophical apparatus, and the coarser sizes are also made in iron. They vary very considerably in quality and uniformity, and a careful selection should therefore be made. A series of fine lines ruled upon paper may be utilized, but such are more difficult to obtain of the desirable regularity, and the final result is scarcely equal to that given by wire gauze.

In photographing the latter, it should be strained evenly in a wooden frame, which must be fixed in such a position that an even and not too powerful light passes through it to the lens. On no account should direct sunlight or direct daylight of any kind be employed; reflected sunshine is too powerful, and the best result is obtained by a subdued diffused light reflected from a *matt*, white surface. These conditions are secured by arranging the screen at an angle of 45° with a smooth wall or other surface of sufficient extent, properly colored and lighted; and in order to secure the greatest possible uniformity in lighting, it is desirable that the reflecting surface should be considerably larger than the screen to be photographed.

As regards the comparative dimensions of the original and the reproduction, these must, of course, depend upon the material available, and the fineness of grain required in the negative. From eighty to a hundred lines to the inch will generally be found fine enough, and a clearer and sharper result will be obtained by reducing from a mesh three or four times as coarse than from finer material. Another point that requires to be taken into consideration, too, in the matter of reduction is the relative proportions between the thickness of the wire composing the gauze and the apertures. Very considerable differences can be produced in the character of the grain by paying attention to this matter, but it must always be borne in mind that the greater the number of reductions beyond three or four, the larger will be the surface required, and, consequently, the greater the difficulty of securing mechanical perfection and uniformity of illumination.

The process of reproduction is almost of necessity confined to collodion, either wet or dry. With gelatine films, however perfect for general work, it is practically impossible to combine the necessary conditions of clearness and vigor as well as sharpness required; this arises as much from mechanical as from chemical reasons, while it may be urged in addition against the use of gelatine that the operation of stripping the negative from its glass support is a far more difficult one than with collodion.

The latter may be used either wet or dry, and each form will, no doubt, find its supporters. Wet collodion will, perhaps, be invariably employed by professional photographers and others who may be familiar with its use, but dry collodion or emulsion plates will be, perhaps, more convenient to the average amateur. A dry bromized collodion film, too, has an advantage over wet collodion in that it is amenable to alkaline development, the benefit of which will be alluded to further on.

We will describe the wet process first. The glass employed should be patent plate in order to secure as perfect a surface as possible, and it must be most scrupulously cleaned and polished, a final treatment of powdered tale being given in order to insure the easy stripping of the film negative. The collodion should be as structureless as possible, as any tendency to "crapiness" will, by the introduction of a separate grain, tend to mar the result aimed at. It should not be too heavily iodized, should contain a fair proportion of bromide, about 1:3, and should not be too new. When old enough to have acquired a pale sherry tint, the condition will be satisfactory. The bath is best of the strength of 35 grains to the ounce, thoroughly iodized, sunned, and finally rendered decidedly acid with nitric acid. The conditions, in fact, must be such as to secure the greatest possible clearness, but without any tendency to over-density of image, which is usually accompanied by an inclination to "filling up" of the fine lines.

The delicate part of the process, of course, lies in the exposure and development, which must be so suited to one another that the requisite depth of deposit is secured at one operation, and without any forcing, which only helps to fill up or veil the lines. There is far less difficulty in this respect when working *through* a screen of gauze or other material than when operating upon a series of lines ruled on paper. In the latter case, even the black lines reflect a portion of light, and this, added to the natural tendency to spreading of the action, helps materially toward the undesirable filling up of the lines. When gauze is employed, by shutting off the light between the camera and the screen, which should always be done, the dark lines of the material are absolutely black, and the chances of filling up are confined to the developer; that is, provided the illumination be not too powerful, in which case the lines will be filled up by irradiation or "blurring." Actual experiment alone can fix the proper time of exposure.

With regard to development, the majority of operators will, no doubt, prefer the iron process, and there is really no reason to depart from it. In the production of line negatives for photo-mechanical work, where extreme density is required, many operators prefer to use pyrogallic acid, but for the purpose we have at present to deal with, where excessive density of image is objectionable rather than otherwise, iron will answer every purpose, and in any case will give an image better adapted to intensification after fixing than when pyro is used. The solution should be of the ordinary strength of fifteen grains of ferrous sulphate to the ounce, with rather more than the normal proportion of acetic acid, say twenty minims of glacial, and sufficient alcohol to make the solution flow easily on the plate.

The beginner in this class of work, even though he be an "old hand" at photography, will probably be surprised and somewhat disgusted with his first efforts, and hastily proceed to blame the bath and developer for all sorts of imaginary faults; but let him remember before he applies the developer that the picture or image he is about to bring out is perfectly even grain of such fineness as to be almost, if not quite, resolvable by the unaided eye in the comparatively dim light of the developing room. Before, therefore, he throws the plate on one side as hopelessly "fogged," let him examine it with a magnifier, when the grain will be apparent. A little experience, combined with a comparison of the color of the body of the plate with the corners or edges protected by the dark slide, will enable the development to be judged with a fair amount of certainty, the magnifier being at hand in case of necessity.

Wash well after development, and fix with cyanide of potassium before the plate has access to daylight; wash well again, and if on examination the image be not dense enough, it may be intensified slightly by means of pyro or iron and silver. Or perhaps a preferable method as being less likely to fill up the lines will be to use bichloride of mercury, followed, after careful washing, with weak ammonia or a saturated solution of sodium sulphite. This not being a *developer*, but only an intensifier, cannot fill up the clear lines of the negative if these are without deposit to start with and the film has been well washed. The amount of washing necessary is, however, far less than with gelatine plates.

The negative so produced from a screen of wire gauze or similar material will consist of a network of continuous *transparent* lines or a series of rows of opaque dots. If the positive grain is to consist of continuous cross lines, this is what is required; if on the other hand the picture is to be composed of minute dots, a reverse must be made from the original by contact printing on a dry collodion plate, the same conditions being observed throughout development. Or in case a reversed negative be required, the preferable plan will be that which we have yet to describe.

In this case a dry collodion plate is used, or at least a collodion plate prepared in the same manner as a dry plate, namely, free from all excess of silver nitrate, so as to be developable by means of alkaline pyro. With this condition the plate may of course, if preferred, be used wet, but it is necessary to employ a simply bromized collodion, or at any rate one containing only a very minute trace of iodide. The reason for this is found in the fact that iodide of silver is not readily reduced by the ordinary alkaline developer, and as this method is based upon the removal of the image first formed by the developer, it is obviously necessary, in order to obtain a series of transparent dots, that the proportion of iodide should be extremely small.

The plate may be prepared by sensitizing a plain bromized collodion film in a silver bath of the strength of sixty or, preferably, eighty grains to the ounce, and washing until every trace of free silver has been removed. A far more convenient plan will, however, be to employ a bromide emulsion in collodion. The exposure is made with precisely similar precautions to those already described, and the development effected by means of pyro and ammonia.

The action of ammonia is more thorough and searching than either of the fixed carbonates, for which reason it is recommended. The action of the developer is continued until, under the magnifying glass, the grain is clearly and strongly visible at the back of the plate; in fact, the object is to reduce the whole of the silver bromide on those portions of the plate representing the dots. It is not easy to judge precisely when this has occurred, but a little experience will teach how far the development may be carried to secure this result without overdoing it by reducing the unexposed portions, which would result in loss of vigor in the final image. If the action is incomplete, the second development will veil the image, a more serious evil than the other.

Development complete, the plate is thoroughly washed and placed in a dish with a sixty-grain solution of the double sulphate of iron and potassium, or iron alum as it is called. A solution of *ferric* sulphate may be used, but the first named is more reliable and keeps better. This dissolves the metallic silver forming the image and leaves a negative in which the lines repre-

senting the original gauze consist of silver bromide, and the "dots" or holes of clear glass, the absolute clearness of the latter depending, as has been said, upon the thorough action of the developer. The plate is again well washed, and after a brief exposure to light again treated with alkaline pyro to darken the silver bromide, when an image of absolute clearness and great density is obtained.

The advantage of this method is that there is not the slightest tendency to fill up the transparent lines of the final negative. These, if the development has been carried far enough, have absolutely no silver to be acted upon by the second developer, and consequently remain perfectly transparent, under which circumstances the development may be continued for any length of time without injury. This process produces the finest combination of vigor with clearness, and enables *quick-printing* grain negatives to be made which are at the same time perfectly opaque in the lines.

The negative having been completed, the next step toward rendering it available for use is to transfer it from its glass support and convert it into a film negative. This, though a somewhat troublesome operation with gelatine, is a comparatively easy matter, fortunately, when collodion forms the vehicle for holding the sensitive salts, and a variety of methods of transfer offer themselves for choice; but whichever may be selected, it is imperative that one or two simple precautions be taken to insure the clean stripping of the collodion film from the glass.

Directions have already been given at an earlier stage for the preparation of the glass with French chalk previous to coating with collodion. Instead of that, if preferred, a solution of pure beeswax in highly rectified benzole free from grease may be applied to the plate, and polished off with a clean silk rubber until a barely perceptible trace of the wax remains; but the French chalk plan is perhaps the more reliable and the easier of application. This treatment, while it causes the collodion film to adhere better to the glass during the various operations of development, washing, etc., causes it, curiously enough, to strip with greater ease when the film is dry. With a perfectly clean plate and suitable collodion it is not absolutely necessary, but the preliminary treatment goes far to insure a successful issue.

Another point to be looked to is the thorough washing of the negative before the final drying, as if any trace of chemicals be allowed to remain in the collodion film, it becomes more liable to tear, as well as to stick to the glass in places where the stripping is attempted. In order, therefore, to insure the perfect removal of every trace of soluble matter, it is well, after a thorough rinsing under the tap or from a jug, to allow the plate to soak for a few minutes in hot distilled or rain water previous to drying. Further, whatever the final process of transfer may be, it is necessary that the collodion film be first dried, as this, by the shrinkage it causes, enables the film to detach itself more readily from its support.

The methods of transfer may be divided into two classes, namely, those in which an already prepared transparent film is caused to adhere to the negative, and those, again, in which a solution is poured on to it and allowed to dry into a skin of suitable thickness. The first are in some respects perhaps simpler, though requiring considerable care; but the results obtained with the latter are, on the whole, more satisfactory.

The choice of materials for the former process consists of thin sheet gelatine, either soluble or obtained at the dealers in artists' materials, or in the insoluble form as now employed for negative purposes. Celluloid in the thin sheets now obtainable is also available, but that employed for cut sizes of negatives—that is to say, the unrollable—is rather too thick for some purposes, though it answers very well.

In using the soluble gelatine sheets it is, of course, necessary that the material be thoroughly softened and swelled by immersion in cold water before applying it to the negative, and this brings us to the first difficulty, namely, its curling up under the action of water. However, a little skill and patience will overcome this difficulty, and the natural adhesiveness of the gelatine then suffices to cause it to attach itself firmly to the collodion negative. The latter must be immersed in perfectly clean, cold water, free from dust or floating particles, until the collodion film is thoroughly permeated; it must then be introduced, film uppermost, into the same dish as the softened gelatine skin, which is allowed to float over it, when the operator, taking hold of both negative and transfer skin by opposite corners in the manner well known, slowly draws them out of the dish in such a way that the water runs evenly from between them, leaving the two surfaces in intimate and perfect contact. Should any air bubbles remain between, it is preferable to float off the skin again and repeat the operation rather than to attempt to smooth them out by squeegeeing or other pressure, owing to the extreme tenderness of the collodion film. A gentle stream of water allowed to flow on to the film, or careful treatment with a camel hair brush, in slight cases will often prove effectual; but there is always a danger of injury to the collodion as well as to distortion of the gelatine.

Assuming perfect contact to have been secured, the edges of the transfer skin, which in its swelled condition should extend each way half an inch beyond the edges of the glass, should next be carefully folded over the back of the latter, the negative being meanwhile placed face downward upon a sheet of plate glass with a piece of fine, damp linen stretched tightly over it. The edges may then be accurately and neatly arranged and brought into contact, a little gum or albumen being used if desired to insure perfect adhesion. Great care must be observed not to move the negative while this is being done, or the collodion film will be damaged; and when the work is complete, it is lifted from the underlying plate glass by means of the intervening linen, and the latter then carefully peeled away and the negative set away to dry.

If insoluble gelatine or celluloid be employed, the proceedings are practically identical, with the exception that an adhesive will have to be employed to attach the transfer skin to the collodion film. The trouble arising from the curling of the new support will be avoided in the case of these materials. In applying a soluble adhesive to either negative or transfer skin, or both, there is always a danger of its penetrating the collodion and causing it to adhere to the glass permanently, unless, indeed, the adhesive be in such thick solution as to be practically unmanageable for the purpose. The best plan is to first coat the transfer skin with a thin layer of chrome gelatine, *i. e.*, gelatine containing a small trace of chrome alum, and to allow it to set thoroughly, or even to become quite dry. The grain negative is then wetted as in the previous case, and the transfer skin applied in exactly the same manner, the subsequent operations being identical, with the exception that in the case of ordinary celluloid it will not be possible to fold over the edges. This, however, thanks to the adhesive used and the absence of contractility, is not now so necessary.

The negative, when covered with its transfer skin, is then placed in a not too warm place, free from dust, until it is perfectly dry. It is not advisable to attempt to hasten the drying by means of a *strong* current of air, less still by heat, but when apparently quite dry the temperature may be raised to insure the removal of the last traces of moisture, after which the negative should be exposed for some time to ordinary atmospheric conditions, in order that it may resume a normal state before stripping. This is effected in the ordinary way by cutting round the edges of the negative with a sharp penknife, and then, raising one corner with the thumb and finger, gently but firmly peeling the compound film from the glass. It may be advisable in the case of either of the gelatine stripping films, to coat with transfer collodion before removal from the glass. After stripping, the negative should be immediately placed under pressure for a short time.

Of the materials available in the alternate method of stripping may be mentioned solutions of India rubber or gutta percha, collodion, and gelatine; but the advantages of the last are so great that we shall confine ourselves to the description of the method of its use. For the purpose, all that is required is a strong solution of gelatine, with the addition of a slight trace of hygroscopic matter to give it flexibility. For the purpose, we know of no better formula than that published by Mr. J. W. Swan, some six and twenty years ago, which we have long employed for similar purposes with the greatest satisfaction. It consists of—

Gelatine	1 ounce.
Glycerine	½ drachm.
Water	4 ounces.

The solution is made in the ordinary way, and must of course be filtered through linen, or other suitable material. A small proportion of alcohol—not more than five per cent.—may be added to hasten the drying, but it always introduces a danger of unevenness of film without any very considerable acceleration of the drying.

The dried negative is warmed to about 140° Fahr., carefully dusted and placed on a leveling stand, and sufficient of the foregoing gelatine solution poured on to it to form a layer about an eighth of an inch deep when liquid. This part of the operation must be performed with celerity, as if the plate get cold, or the gelatine become chilled, it will, owing to its thickness, set unevenly. If this occur, the plate must be rewarmed, the gelatine poured off and reapplied. The plate is allowed to remain on the level until thoroughly set, when it is transferred to a moderately warm drying cupboard, perfectly free from dust. In a well ventilated chamber or cupboard the drying will be complete in about twenty-four hours, when the film may be coated with transfer collodion, and when that has dried, stripped in the manner already described.

This gives us a film negative consisting of soluble gelatine "sandwiched" between two films of collodion, which is, of course, liable to all the vicissitudes of gelatine films. It is questionable whether any great advantage is likely to accrue in practice from the substitution of an insoluble, or, at least, partially insoluble gelatine film, since, though the latter will not *dissolve*, it is equally prone to swell and cockle in the same manner as the soluble film under accidental damp. And as such negatives are scarcely likely to be subjected to such conditions as to be in danger of solution, the advantage is dubious. In practice we have never found the slightest inconvenience from the soluble gelatine film.

If, however, any of our readers desire to be ultra-particular, and render the stripping film insoluble, they may introduce a little chrome alum into the gelatine solution. But with a thick solution, such as that given, the use of chrome alum is attended with grave inconveniences if used in anything like useful proportions, hence we prefer the following modification, though, of course, the soluble film may be immersed in chrome alum after drying. Instead, therefore, of incurring the necessity for a second drying, and with a view also to avoid the dangers arising from the introduction of chrome alum into the gelatine, we prefer to substitute potassium bichromate, adding two to three grains to each ounce of solution. The negative is leveled and coated with this in the ordinary way, and when perfectly set it is immersed in a solution of moderate strength of bisulphite or metabisulphite of potash previously cooled to as low a temperature as possible. This reduces the bichromate and forms chrome alum in the film, thus producing the effect desired.

Or another method of using the bichromatized gelatine gives a result that is practically identical with the Vergara or Froedman film, which has the additional advantage of swelling but slightly under the influence of water.

In this case allow the bichromated gelatine to dry, and then expose to strong daylight for an hour or two the back and front of the negative. This renders the gelatine quite insoluble, and a subsequent immersion in the solution of bisulphite of potash will remove the brown color caused by the bichromate. If this color seems reluctant to discharge itself, a little hydrochloric or sulphuric acid added to the solution will hasten it. After this treatment it will be necessary to wash well, and the film will then dry in a short time, and can be stripped in the usual manner.—*Br. Journal of Photography.*

CHARLES BOURSEUL.

CHARLES BOURSEUL.

WE give herewith a portrait of Charles Bourseul, to whom attention has recently been directed by Mr. Jules Roche, minister of commerce, in recalling the fact that in 1854 this young and modest scientist published an article concerning the experiments in telephony that he had undertaken at that epoch.

In fact, this is what Bourseul wrote in *L'Illustration:* "I asked myself whether speech might not be transmitted by electricity, in a word, whether it might not be possible to speak to Vienna and make one's self heard at Paris. The thing is practical, and here is how: Sounds, as we know, are produced by vibrations, and carried to the ear by these same vibrations reproduced in the intermediate space. But the intensity of these vibrations diminishes very rapidly with the distance, so that, even with speaking trumpets and speaking tubes, there are quite circumscribed limits that cannot be exceeded. Imagine that we are speaking near a movable plate that is flexible enough not to lose any of the vibrations produced by the voice, and that this plate successively establishes or interrupts communication with a battery, and you may have at a distance another plate that will at the same time undergo exactly the same vibrations. . . . I have begun the experiments; they are delicate and require time and patience, but the results already obtained allow us to foresee a favorable outcome."

As may be seen, it was not a confused idea that Bourseul had of the telephone. His experiments and his theory responded exactly to what modern science has realized of the precisest and most technical. Why did he not succeed? He himself unwittingly answers this question: "When the idea of applying electro-magnetism to the transmission of dispatches was spoken of for the first time," writes he in the same article, "a

man with a high place in science treated this idea as a sublime chimera, and yet to-day we communicate directly from London to Vienna by a simple wire. That was not possible, said one, and yet it is. However it may happen for telephony, it is certain that in a more or less distant future speech will be transmitted by electricity. An electric battery, two vibrating plates and a wire will suffice." His sublime chimera was not encouraged, and a foreign country seized it.

Charles Bourseul, who was born in 1830, is the son of an army officer. He was educated at the college of Douai. In 1852 he entered the administration of telegraphs at the moment when this new science was still in its swaddling clothes.

In 1886 he was appointed chevalier of the Legion of Honor, with the following mention: "As long ago as 1854 he laid the basis of telephony."

The administration of telegraphs is indebted to him for a host of improvements, and, among others, for the Bourseul commutator. The modest scientist is all the time at work, and for several years has been occupying himself with the microphone. While he has rendered services to science, his brothers have rendered others to their country. One of his brothers, a young infantry captain, was killed at the head of his company at the battle of Beaumont. Another one is at present in command of one of our regiments of light cavalry, and is one of the most distinguished officers of our army.

Our readers will feel grateful to us for having presented to them these devoted servants of our country. The scientific mission that the government has just confided to Charles Bourseul, and the object of which is to make researches upon the improvements to be introduced into the telephone service, is but the beginning, we hope, of the reparation that is due him.—*Science Illustrée.*

PROGRESS OF ELECTRIC WELDING.

WITHIN the few years of its rapid development electric welding and metal working has taken a prominent place in the industrial world. The very ingenious apparatus which is now in considerable use has succeeded admirably, says the *Electrical World*, in accomplishing many difficult feats in welding and forming various materials. As is now known to every one, the process as generally used simply depends on the heating of the abutting ends of the metal to be welded. By the passage of a current of electricity across the surface of contact, it is done with admirable success and rapidity, but the volume of current required is necessarily very large. The heating is obtained by virtue of quantity of current, and to raise any considerable mass of material to a welding temperature requires an enormous expenditure of electrical energy, lasting, to be sure, only a short time, but, nevertheless, requiring special conditions for its production and utilization. The modern electric welding plant has up to the present required special forms of apparatus, which, however efficient, somewhat limit the applicability of the general processes of the electrical heating of metals to workshops large enough or placed favorably enough to secure the necessary current.

We show herewith some very ingenious modifications of the general idea of electric welding, having for their purpose the reduction of the maximum amount of current required, and, what is no less important, utilizing the heat of electric energy in such a way that welding can be done with ordinary currents from common and readily available machines, so that wherever an arc or incandescent circuit is available, welding can be successfully carried on. The various devices are the invention of Mr. C. L. Coffin, of Detroit, Mich., and the fundamental principle on which he has worked may, perhaps, be called that of an electrical blowpipe.

The illustration, Fig. 1, is from a photograph of an arc welder, in actual operation. The general principle employed is the heating of the points of contact, or rather heating of the surfaces to be welded, by the application of the electric arc formed between two converging carbon pencils and blown downward like a blowpipe flame by the influence of an electro-magnet. The hoop held in the anvil clutches is subjected at the joint to the intense heat of the arc sprung between the carbons and projected downward by the magnetic blast. The arc and current regulating mechanism is carried in a box supported by the sliding yoke which is elevated from the arc by the lever shown. The switch at the lower left hand of the figure regulates the intensity of the magnetic blast, thus lengthening and shortening the electrical blowpipe flame, while in addition by raising and lowering the magnetic cores the blast may be regulated within certain limits without employing a switch. The anvil clutches are provided with interchangeable heads adapted to straight, curved, and irregular work. The depresser lever also admits of the material being submitted to any desired exposure to the arc at the will of the operator. Fig. 2 shows the simple portable arc welder intended for small work such as may be found in tin shops, plumbers' shops, and in light metal work generally. The frame is supported upon insulating rollers, and carries the regulating apparatus. The magnetic blast can be regulated in two ways—by raising or lowering the threaded core, or by a switch. A scale is provided so that a tool may be set for working upon metal of different thicknesses, and this is so calculated that when the index hand is set to a figure denoting the gauge of the material operated upon, the best result will be obtained.

The great beauty of this arc welding is that it places at the disposal of the operator an enormous temperature which can be applied to just the point desired, and all this is available wherever an electric circuit can be obtained. It may be placed on any continuous current circuit, or operated from any dynamo intended for arc or incandescent lighting. Where it is impossible to secure service through a central station, a small isolated dynamo may be used. It is almost literally an electrical blowpipe of enormous power and ready applicability to all sorts of conditions. The expense of installation is comparatively light on account of the simplicity of the apparatus and because no special dynamos have to be installed. The cost of maintenance is something like that of an ordinary arc lamp, of which the ordinary welder is about the equivalent in energy consumed. As it is sometimes necessary to reenforce a weld, this contingency has been provided for by other appliances, whereby the re-enforcing material can be supplied in semi-molten condition at the point desired. For special purposes an air blast is sometimes used in connection with a magnetic blast. Of course it should be said that the welding of steel by this process requires some special precautions by reason of the intense heat at hand, but the work can be successfully done, and other metals are as manageable by this as by any process.

FIG. 1.—COFFIN'S ARC WELDING MACHINE.

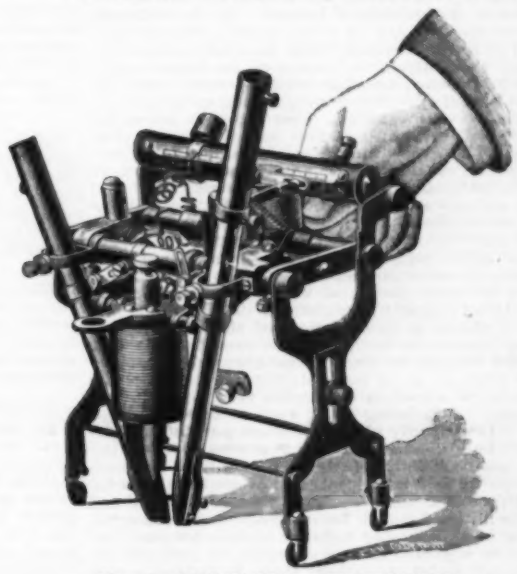


FIG. 2.—PORTABLE ARC WELDER.

The apparatus shown in Fig. 3 is a modified form of welder whereby the material may be heated in three ways, by incandescence as in the common process, the arc, or by both, the material being secured in the clamps as in the illustration. The workman turns on

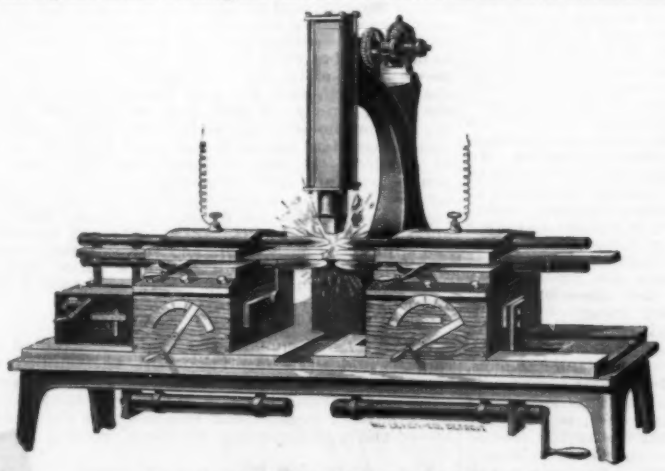


FIG. 3.—AUTOMATIC ARC WELDER.

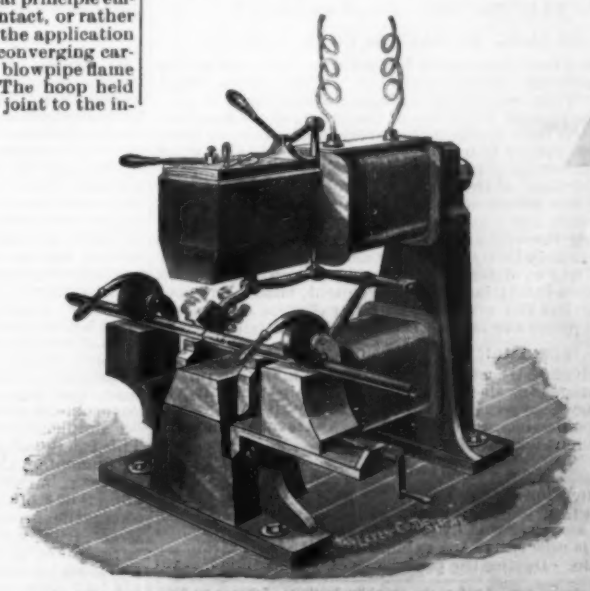


FIG. 4.—IMPROVED INCANDESCENT WELDER.

the current. The arc is then formed between two pairs of carbons upon each side of the material. It will be seen that the extremity of the metal in this instance is subject to the intense heat of the arc. When the temperature is sufficient for welding, the small switch seen at the left is moved over one point, which throws the carbon and carbon-regulating apparatus shown on the left out of circuit and energizes the electro-magnets contained in the base of the clamp blocks. At the same time the releasing mechanism causes the pairs of carbons to recede, and the magnets being attracted toward each other, draw the material together at a steady, uniform pressure, which can be regulated to any temperature or degree. The electro-magnet carried on the traveling block to the right is wound in sections or separate bobbins, the terminals of which are connected with the switch points, so that the work can be effected in almost any desired way by the influence of the magnet above it. When sufficient pressure has been applied by moving the small switch one point more, the little motor operating the electric hammer can be put in operation. The anvil block under the material first moves forward, and then the electric hammer is automatically thrown into operation. This may be arranged in various ways. In the machine illustrated the drop is suspended in a solenoid of many spools, and terminals are brought up in a double commutator so arranged that ordinating impulses are given when the contacts are revolved over the face of the commutator. They are so arranged that the force of the blow can be regulated. The speed of the motor can be governed by the switch rheostat shown at the left and carried on to the base of the clamp blocks. When the weld has been sufficiently hammered, the hammer is thrown out of circuit and the anvil thrown back from under the work, cutting out the motor when it reaches its place.

This machine is also arranged so that the carbon may be dispensed with and the arc sprung between the extremities of the material if desired. In this arrangement the magnets are in shunt around the arc so arranged by resistances that when the resistance of the arc and the material by reason of its being highly heated has reached a certain predetermined point, the current is shut off. The arc-regulating apparatus and the magnets automatically press the weld home, the hammer is thrown into action and the weld applied as before. For very thin material this machine is provided with a cut-out to the arc-regulating device, so that the material is heated by the current itself and by the carbons which are brought together and between which the material rests. The whole machine is of a most novel character and is reported to work with beautiful regularity. It is so constructed that the same pressure and amount of hammering can be applied to many thousand welds without variation, thus making it nearly automatic in its operation.

Fig. 4 shows a modification of the incandescent welding process for the purpose of localizing the heat and producing an unusually great electrical resistance at the joint, so as to facilitate the initial part of the operation, which often demands a very large amount of current. A resisting body, such as a thin sheet of mica, is temporarily placed between part of the surfaces to be welded and withdrawn when the welding action has been fairly started. In addition, a powerful magnetic field is concentrated around the joint for the purpose of aiding in the same action. It is claimed that the initial demand for current on incandescent welding is considerably reduced by this process, but it is to be regarded as a modification of ordinary incandescent welding rather than a distinctly new operation like the arc welding. It seems altogether probable that the arc welding machine may find a very considerable use, especially as it may be made very small, so that it can be handled with the greatest facility. By no other means known can so enormous a temperature be regulated and adjusted with such facility. Mr. Coffin even proposes to make a very minute arc welder for jewelers' use and the smallest metal work—a little tool that can be handled almost as readily as a pencil. While, of course, unable to cope with large work, it would be exceedingly handy in small operations of metal working.

The whole arc process is for obvious reasons a most convenient one, and is as neat theoretically as it is said to be successful in practice. The idea of handling the electric arc as one would a blowpipe, with a magnetic blast instead of air, is certainly a very beautiful and ingenious application of theory, and while the full details of the work done have not been made public, the apparatus has been sufficiently tested to show that it possesses very many useful qualities.

ELECTRICITY IN WARFARE.*

By Lieut. BRADLEY A. FISKE, U. S. N.

ABOUT four years ago a lecture was delivered before this Institute on the subject of "Electricity in Warfare." This evening the endeavor will be made to present the present condition of the art, to show what advance has been made in the intervening years, in what ways electricity is now actually employed, and what is the direction of progress.

At the time of the previous lecture, November, 1885, nearly the whole science was in a transition stage. Electricity was just emerging from the laboratory and entering the region of practical life. There was but one war ship lit by electricity actually at sea, and her plant was so defective, and accidents on board from imperfect insulation were so frequent, that many concluded that the only effect of her electric equipment was to prove the impracticability of the attempt.

ELECTRIC LIGHTING FOR WAR SHIPS.

Much of that lecture was devoted to maintaining the advantages of electric lighting for ships; now it will be unnecessary to do more than to say that every war ship possessing any pretensions whatever to modern equipment is lighted by electricity.

SUBMARINE MINES.

As mentioned in my previous paper, the first practical plan for employing electricity in warfare was proposed and executed by Col. Samuel Colt, and embodied what is now called the submarine mine, or stationary torpedo. During the past five years it cannot be said that very much progress has been made in submarine mining, for it had then reached a very advanced stage, so that it was practicable to lay out in any harbor a system of electric mines which could be relied upon to blow up any hostile ship trespassing on the premises, and to allow any friendly ship to pass without molestation. Defending a harbor with mines is simply carrying out with more or less elaboration a system by which a large number of water-tight tanks, holding from 100 to 1,000 pounds of gun cotton or other explosives, are anchored in carefully defined positions and connected by electric cables with protected operating rooms, in which are batteries, measuring instruments, etc. The more complete mines have usually floating above each of them an automatic circuit closer, in which two contact points are jarred together by a passing ship, and thus afford a passage for the electric current to the fuse in the torpedo. Ordinarily this current is a weak one, sufficient only to close a relay in the operating room, which sends in turn another current through a bell or other indicator, but not strong enough of itself to fire the torpedo. But when hostile ships are expected, then the relay is arranged to throw in a strong current, strong enough to heat the fine platinum iridium wire in the fuse, and ignite the fulminate of mercury. This fulminate detonates a primer of dry gun cotton, and this, in turn, detonates full charge of damp gun cotton in the torpedo.

SUBTERRANEAN MINES.

Closely related to submarine mines are subterranean mines, which have been used satisfactorily in land warfare, being sown in places over which the enemy might be expected to pass, especially in the approaches to a fort or other intrenched position. The mines may be fitted with percussion fuses or with electrical connections, such that they can be exploded by an operator within the intrenchments, whenever the enemy arrives at the proper place. The result of the explosion of one of these mines in the midst of an advancing regiment cannot be pictured with comfort. The present system, in which troops are kept in open or skirmish line, rather than closed in mass, will probably result in a larger number of mines, each mine comparatively small.

SPAR TORPEDO.

In my previous paper much space was given to the spar torpedo, in which the explosive was carried on the end of a spar, and was designed to be shoved against the underwater side of a hostile ship. Nothing need now be said about it, except that it is becoming rapidly a thing of the past; perhaps not rapidly enough.

LAY TORPEDO.

With the auto-mobile torpedoes, like the Lay, in which the directing power, though not the motive power, is electricity, not very much change has come to pass. The torpedo occasionally is exhibited, and shows itself capable of doing good service under certain conditions.

SIMS-EDISON AND HALPINE-SAVAGE TORPEDOES.

In torpedoes in which the motive power as well as the directing power is electricity, considerable improvement can be seen, notably in the Sims-Edison and the Halpine-Savage. The principal difference between these two types resides in the fact that the power for the Sims-Edison is transmitted to it along the wire, while in the Halpine torpedo it is carried on board in storage batteries. The Halpine torpedo has additional features also, by means of which a projectile can be discharged from the bow, when it strikes any resisting object, such as the underwater body of a ship or the projecting net, and by which this act of discharge reverses the propelling motor, thus causing the torpedo to back away from danger. The projectile, meanwhile, keeps swiftly on its way, and when it reaches a certain distance, *i. e.*, the length of a small chain connecting it to the torpedo, it is exploded. The field for torpedoes of this class seems to be the coast, harbors and rivers of a country, rather than the open sea.

WHITEHEAD TORPEDO.

In the practical service of the far-famed Whitehead torpedo, of which there are probably more in existence than of all others combined, it has been found that electricity gives a more precise control of the time of starting than any other means.

HOWELL TORPEDO.

In the Howell torpedo, which is rapidly coming into prominence as the superior of the Whitehead, it is now contemplated to employ electric motors to produce the rapid revolution of the fly wheel, which stores up the energy needed for propulsion.

MILITARY TELEGRAPH SERVICE.

In armies, aside from submarine and subterranean mining, the principal use of electricity is in the military telegraph service, and its importance there can hardly be overestimated. One great cause for the suddenness and completeness of the German victory in 1870 was the rapid mobilization of the Prussian army, and its appearance on the frontier, ready for battle. Now the splendid efficiency of the telegraph service in the hands of the military authorities made this possible. Nothing is more essential in warfare than dispatch and precision in moving the enormous bodies of men of which armies are composed, with all their ammunition, equipments, supplies, and numberless accessories. To move a quarter of a million of men to the frontier in one day means a great deal; and to maneuver so large a body in the field with such precision and rapidity that no one division shall have to wait for any other division, simply cannot be done without electricity. In military countries, and in all countries during war time, the regular telegraph lines are pressed into government service; but in the field these lines must be supplemented by the military telegraph proper. This is a separate organization, with special duties and equipments. Carefully designed wagons carry wires on reels, batteries, telegraph instruments, telephones, etc. Some of the wire is insulated, and is run rapidly along the ground, just as at a fire a hose is laid in a street from a rapidly moving hose cart; some of the wire is bare, is intended to be put on hastily erected poles, and on trees, sheds, etc., or sometimes to be simply laid along the ground and used in connection with telephones, automatic circuit breakers and telegraph keys. It is doubtless well known to all here that a telephone can be used in this way, even though it occasions a great waste of current, the telegraph key being manipulated in the ordinary way, and the automatic circuit breaker causing a loud sound in the telephone whenever the key is closed.

BALLOON OBSERVATIONS AND BALLOON SIGNALING.

As part of the military telegraph service, foreign armies have used balloon signaling considerably, and it will probably be an important factor in any future war. The movements of an enemy's forces can plainly be seen from a captive balloon at a height of say 1,000 feet, and the result of the observations telephoned down to the officers stationed on the ground. Balloons have also been used in signaling to a distance, an incandescent lamp being suspended beneath, which is made to glow at intervals and to thus signal letters and words in accordance with a preconcerted code.

BALLOON PROPULSION.

As regards balloon propulsion, many experiments have been made, notably by Tissandier, who has accomplished wonders in propeiling balloons against the wind, using small storage batteries and very light electric motors. Nevertheless, it cannot be said that the advent of balloon propulsion can be seen anywhere upon the horizon of the future; while, at the same time, the rapid increase of speed and facility in travel, telegraphy, telephony, and mail communication is daily rendering ballooning more and more unnecessary.

INSPECTION OF GUNS.

Among the minor military applications of electricity, there are in use all over the world a number of such devices as small incandescent lamps arranged to illuminate the bores of guns, velocimeters, etc., for inspection.

VELOCIMETERS.

Velocimeters are of countless forms, but in all, some kind of time-measuring instrument is set in motion by a projectile striking one wire and stopped by the projectile striking another wire. The distance between the wires being known, the interval of time recorded is the measure of the velocity of the projectile while passing over that distance. In the same category is an electric chimograph, which records the exact instant a projectile starts and when it leaves the bore.

ELECTRIC CONTROL OF WAR SHIPS.

But it is in the modern war ship that we find electricity in its broadest field. In no other equal space can there anywhere be found so many, so various and so important forms of apparatus. The reason is apparent. The modern war ship is the most intricate, tremendous and powerful machine existing. The fate of a nation may, at a crisis, depend upon a single shot. Everything must be done to contribute to her speed, endurance and effectiveness. She must be under quick and absolute control at all instants. She must respond at once to the will of her captain, and her whole strength and power must be his, as though it were a part of him. Ensconced in his conning tower, he must be the brain of the gigantic body. Electric wires must, like nerves, convey instant tidings to him from her innermost recesses, and electric wires flash back from him the inevitable command. The enemy being in sight, the captain must, at each instant, know her exact distance and direction in order that he may lay his guns accordingly. These guns must not be apart from him, under only general control, but he must have them absolutely in his hand, and make them do his will. This does not mean that he must concern himself with details or himself press the key that fires the guns; his gunnery officer, a specialist, can do that; but the gunnery officer must have the proper apparatus under his personal direction, and fire the guns with the precision given him by his skill and experience, and the captain must personally direct the gunnery officer. As for the guns, they must always be bearing on the enemy, and always correctly elevated for the distance, so that they will be ready to fire as soon as they are loaded; no delay can be tolerated.

HANDLING HEAVY GUNS BY ELECTRIC MOTORS.

For quickly bringing heavy guns to point at the target, hydraulic machinery is usually employed in the navies of Europe. But in the U. S. S. Chicago, our newest and best cruiser yet at sea, one of the eight inch guns is trained by an electric motor, and with gratifying results. The gun can be trained much quicker than by hand, but this is not the real element of superiority. The real element is the absolute control possessed by the gun captain. Ordinarily he is forced to tell somebody else which way to move the gun, and how far. With the best drilling and the coolest men mistakes and delay occur. But with the present apparatus, the gun captain, or second captain, actually moves the gun himself, just where he wants it. Of course, no man is physically strong enough to accomplish this unaided. But the motor aids him almost without his feeling it. A small lever protrudes in rear of the gun, and this lever is so connected with a peculiar switch on the motor that the gun follows the lever like an obedient child. If the gun captain wishes to move the breech of the gun to go to the right, he moves the lever to the right, as though it were really the gun itself, and the gun immediately moves to the right, slowly or fast, just as the lever moves. And when the lever stops, the gun stops. The reverse operation occurs if the lever is to be moved to the left. It will be seen that this plan dispenses with any arbitrary motions, so that a person entirely ignorant of electricity can control the gun just as well as could Sir William Thomson. The nicest and smallest movements can be obtained, as well as the largest and most rapid, and the big gun, capable of throwing a 250 pound shell nine miles, carrying death and destruction with it, can be handled by a child.

ELECTRIC AMMUNITION HOIST.

But it is not enough that guns be handled with rapidity and precision. They must be supplied with a constant stream of ammunition. The problem of supplying ammunition with sufficient rapidity to carry on a modern engagement is coming to the front as one of the most important problems pressing for solution.

The ammunition hoist now on board the Atlanta is a step in this direction, furnishing as it does a means

* A lecture delivered before the Franklin Institute, January 20, 1890. From the *Journal*.

for raising ammunition to the deck quicker than by hand, with greater safety and with fewer men, thus allowing the extra men to work at the guns. In this hoist, as in the gun-training apparatus, the same idea is carried out, *i. e.*, that of making the electric motor follow the motions of the operator's hand, both in direction and in speed. The operation of turning a wheel or crank causes the switch to start the motor in a certain direction, and the consequent motion of the motor operates to close the switch, so that a race ensues between the operator and the motor. If the operator begins to decrease the speed with which he turns the crank, the motor will overtake him, and will partially close the switch, and the motor will, therefore, lower its speed; whereas, if the operator increase his speed of movement, the switch will thereby be opened further, and the motor will go faster. The advantage of this plan in the case of an ammunition hoist will be apparent when it is stated that the entire time required on board the Atlanta to raise a 250 pound shell is nine and a half seconds. Now, this interval gives a man very little time to think, especially in excitement or danger. And if the ordinary arbitrary movements for starting and stopping motors were employed, an accident would, some day, result from the wrong movement being made. Furthermore, with this device, if the operator is killed, or if he lets go the handle, or if, through excitement or confusion, he ceases to pay attention to the handle, or if a shot disables the motor, or breaks its connections—in all these cases, everything stops, and the shell simply stays where it is. This is a much better thing for it to do than to violently descend, or be forced up against the deck overhead, as would happen with any other device now known.

ELECTRIC MOTORS AS AUXILIARY ENGINES IN WAR SHIPS.

The two plans above described comprise the only uses, besides ventilating, to which electric motors have as yet been put in ships. But in the near future, it is expected that they will largely replace the many small steam engines with which modern war ships are filled. The most complete and detailed statement of the scope of motors for ship use is the lecture of Mr. S. Dana Greene, formerly an ensign in our navy, before the Naval Institute. Mr. Greene, from his training as a naval officer and his practical experience as chief engineer of the Sprague Electric Motor Company, is probably more intimately acquainted with the technical features of the case than anybody else. He states that for a ship like the Chicago the auxiliary engines that could advantageously be replaced by electric motors are about forty or fifty in number, and aggregate about 200 horse power. This estimate includes only those auxiliary engines which are at some distance from the engine and boiler rooms, and which, at present, have to be connected to the boilers by very long, crooked and expensive copper pipes. Everybody here knows that a prime necessity in a war ship is to have the pipes that convey steam, compressed air or hydraulic power well below the water line. And everybody knows besides that a war ship of to-day is made up of a great many watertight compartments, and so it will not need a great amount of explanation to give them an idea of the trouble, complication and expense of leading the numberless pipes through the watertight bulkheads and around obstructions. How much easier, cheaper and safer to run wires! A wire can be bent and twisted to any extent, provided only that its insulated covering be not broken. Steam pipes, furthermore, always contain more or less condensed steam, or water, the amount varying with the conditions of the case, and the conditions existing with the long and crooked steam pipes of a ship are such as to cause the amount of condensed steam to be very great. Now this condensation, together with the friction, causes a very great decrease of pressure of steam in the engine cylinder and a great increase of back pressure, so that the steam and vacuum gauges in the engine room convey no idea whatever of the state of affairs at an engine 200 feet distant. In other words, there is great loss of energy between the boilers and the engines situated at a distance from them. But with the electric motor, we can certainly count on at least eighty per cent. efficiency, or at least seventy per cent. of the horse power of the dynamo's engine, and this engine is itself very economical and is placed near the boilers. But more than all this, the simplicity, noiselessness and cleanliness of the electric motor itself stamp it as the ideal engine for ship use, when compared with the noisy, dirty steam engine, with its joints, and valves, and stuffing boxes and other features requiring incessant inspection.

SEARCH LIGHTS IN SHIPS.

At the time of my previous lecture, I endeavored to show the advantages of the search light for offensive and defensive operations. This would be unnecessary now, for these advantages are admitted. At that time the great body of naval officers in all countries were skeptical concerning it, and very many of the most able officers laughed at it as a manifest absurdity, and stigmatized its advocates as those horrible monsters—theorists. Moreover, not a few official reports were made which damned search lights with faint praise, calling in question their effectiveness and exaggerating their limitations. But, of late, the weight of professional opinion in their favor has become enormous, and the endeavor is now simply to find out the best way to use them, under the various phases of war. Let any one take his stand on the deck of a ship at night, knowing that an attack—even a sham attack—is to be expected. Let him feel for a few moments the helplessness that is born of darkness. Let him strain his eyes and his ears in vain to detect the faintest glimmer or the faintest sound to betray boats which he knows are somewhere stealing to the attack—then let the search light dart out its brilliant ray, and throw out into merciless distinctness every detail of some boat 1,000 yards away—swiftly and stealthily advancing—and he will need no subtile arguments to prove to him that the search light has come to stay. Of course, one must know how to use the light and when. One must not show it when he wants to keep his position secret from the enemy. Neither must he use the steam whistle. But because a device may be used disadvantageously is no argument against using it advantageously. And it is a fact that, in all the recent naval maneuvers abroad, the search light has been employed to a great and increasing extent.

SEARCH LIGHTS IN FORTS AND ARMIES.

But it is not only in ships that we find the search light. It is used in forts, notably those defending channels, to watch for attacking vessels, and for boats attempting to countermine; and many of the Continental armies have wagons which carry boiler, engine, dynamo and electric light, for use in exploring battle fields at night and in searching for the wounded and the dead.

SEARCH LIGHT IN FOG.

A novel use of the search light was made one night on board the Atlanta, which was caught in a suddenly descending fog in a very dangerous position in shoal water. It was not deep enough to anchor with safety, in view of the heavy sea, becoming hourly more heavy with the increasing gale; and our position on the shoals was too uncertain to warrant an attempt to get into deeper water, lest we should get into shoaler water instead. The steam launch was lowered, and an officer in it began to sound around the ship, to find a deep channel along which it would be safe to move. But the fog was so thick that it was soon found the launch could not go far enough from the ship, for fear of being lost. At this juncture, Lieut. G. A. Calhoun made the ingenious suggestion that one of the search lamps be lighted, and its beam turned in a certain direction, and the steam launch ordered to sound along the direction of this beam as far as it could be followed. The suggestion was adopted at once. It was found that the brilliant light illumined the particles of water suspended in the air to a surprising distance along a straight and narrow line. The launch would follow the ray as far as it could, sounding as it went, then return to the ship, following the guiding ray. This ray would then be turned in a new direction, and off the launch would steam, to prosecute its investigations along this line. In a few hours a straight and deep channel was in this way found, and with the little launch piloting the way a short distance in advance, and piping its shrill directing whistle, the big ship slowly steamed out at midnight into deep water and a safe anchorage. "This was not warfare," it may be said. No, it was not; but it gives a pithy suggestion as to how in warfare, and under certain conditions, a ship could get out of a blockaded harbor under the friendly mantle of a fog; or how a man-of-war could, under such circumstances, even enter certain harbors. Of course, it would not be prudent to attempt to so enter a harbor filled with automatic electric torpedoes; but these weapons are so elaborate and expensive that they cannot be used everywhere, and on many coasts the main reliance must be placed on ships, shore batteries and torpedo boats.

Not only, however, are search lights of value in enabling us to discover an approaching enemy, they also enable us to see the silhouette of the gun sights on his illuminated surface, and direct the guns with precision on the darkest night.

In cases where it is not desirable to use the search light to illumine the target, a fine wire made incandescent by a current has been used with success to make visible the sights of the gun, which, of course, cannot otherwise be seen at night. The device is so good that one is surprised that it is so seldom used.

AUTOMATIC SEARCH LIGHTS.

In this connection it may be here stated that there is a growing feeling in naval circles in favor of a greater number of automatic search lights, even if of small power individually, in order that all parts of the vicinity may be kept visible. Torpedo boats come so quickly that one cannot afford to let any part of the horizon remain dark while a single beam on the broadside is making the rounds.

SEARCH LIGHT WITH VERTICAL BEAM.

A curious use of the search light has been experimented with, of late, and with interesting results. The lamp is so pivoted that its ray can be projected up vertically, thus throwing a brilliant shaft of light like a silver arrow, high into the air. It is stated that this beam can be seen in a fog further than anything else can. The theory is that a fog does not exist except close to the surface of the water, and that the beam can be seen by looking up into air not much obscured by fog; so that, in other words, one does not have to look through so much fog to see this beam high up in the air as he would to see the ship using the beam. As yet only small search lights have been tried, but they have been sufficiently successful to warrant the similar trial of larger lights.

(To be continued.)

[NATURE.]

THE VELOCITIES OF PROJECTILES.*

THE experimenters whose work is recorded in the papers noted below have succeeded admirably in their attempts to photograph projectiles while moving with their ordinary velocities. At the same time, they have obtained indications of the forms of the waves excited in the air by projectiles when moving with velocities higher than the normal velocity of sound in the air.

The first experiments were conducted by Mach and Wentzel with velocities of the projectiles about 240 m.s. (787 f.s.), which were below the normal velocity of sound, when they obtained only negative results. After this, Mach and Salcher carried on experiments of the same nature with three small arms, which respectively gave muzzle velocities of 438 m.s. (1437 f.s.), 338 m.s. (1100 f.s.), and 522 m.s. (1743 f.s.) The arrangements were such that, when the projectile was in the focus of the camera lens, it caused the discharge of a spark from a Leyden jar at a point in the axis of the lens which was more distant from the lens than the projectile. As the illumination was necessarily of very short duration, the instantaneous photographs were taken on a small scale. These photographs showed a well defined wave of condensation of the air in front of the projectile when the velocity of the shot exceeded that of sound, or about 340 m.s. (1116 f.s.) All the experiments of value were made by the two small arms, which gave muzzle velocities of 1437 f.s. and 1713 f.s. When proper arrangements were made, the photographs of the projectiles fired by these two guns were always very fine and sharp. With a sufficient velocity of the shot, the limit of the condensed air wave in front of the projectile appeared to be of a hyperboloidal form, whose vertex was in advance of the projectile, and axis in the line of flight. Similar traces in the photograph, indicating conical waves whose axes were also in the line of flight, took their rise from the base of the shot. Other but weaker traces of waves of air took their rise from points on the surface of the shot. All these straight lines in the photograph were inclined to the line of flight at a rather less angle than the traces of the head wave. When the velocity of the projectile was increased, the angles which the traces of the waves made with the line of flight were diminished.

When the highest velocities were obtained, the channel vacated by the projectile was immediately filled with peculiar little clouds, which appeared almost as regular and symmetrical as beads strung on a line stretched in the direction of the line of flight. And there was no indication of a vacuum in the rear of the shot, even when the velocity was so high as 900 m.s. (2953 f.s.) As the air was transparent, the form of the waves of air in the photographs must have been caused by the varying density of the air, which refracted the rays of light.

Long ago Robins noticed a change in the law of resistance of the air to projectiles at about the velocity of sound. Although Hutton disputed this change in the law of resistance and others ignored it, recent experiments have completely confirmed Robins' discovery. It now appears that the disturbances caused by the projectile in the air travel faster than the shot for low velocities, so that the compression of the air in front of the projectile is not sufficient to cause traces of waves in the photographs.

The two guns which gave satisfactory results with muzzle velocities of 1437 f.s. and 1713 f.s. showed widely different curvatures at the vertex of the wave of condensation in advance of the projectile. It was therefore very desirable that the velocity of the shot should have been exactly determined at the moment each photograph was taken. This condition has unfortunately not been sufficiently attended to, for although an improvised ballistic pendulum was used in some cases, it was soon discarded.

Afterward the experimenters made use of guns of larger caliber. Salcher carried out experiments at Pola with a gun of 9 cm. (3·5 inches) caliber, which gave a muzzle velocity of 448 m.s. (1470 f.s.) Other experiments were made at Meppen, by Mach, assisted by his son, with a gun of 4 cm. (1·6 inch) caliber, which gave a muzzle velocity of 670 m.s. (2198 f.s.) The head wave appeared as a stronger and broader hyperbolic curve in the photograph, which was rather more in advance of the head of the shot than in the case where small arms were used. But when the velocities of the shot were nearly the same in the two cases, the traces of the waves in the photographs made nearly the same angle with the line of flight. This perhaps might have been expected, as it has been found experimentally that the resistance of the air to projectiles varies as the square of their diameter.

Further experiments were afterward carried out in the laboratory. In this case projectiles composed of various metals were used, as brass, aluminum, and lead, which were of various forms. Attempts were made to determine the velocities of the projectiles in two different ways, neither of which can be regarded as quite satisfactory. In one case it was assumed that the work done on the projectile by a given charge of powder would be constant. But this assumption would not be true for considerable variations in the weight of the projectile. In the other case, the velocity was calculated by using the inclination, a, of the trace of the rear wave in the photograph to the line of flight, on the supposition that the velocity of sound = velocity of the projectile $\times \sin a$.

Much labor and ingenuity have been expended in bringing these experiments to their present satisfactory state. The ground has been well prepared for sets of systematic experiments made with useful forms of projectiles fired with various muzzle velocities. The results given by spherical projectiles might prove useful to the theorist. Other experiments might be carried out with ogival, hemispherical, and flat-headed elongated projectiles. In all cases the readings of the barometer and thermometer should be recorded, and the velocity of the projectile should be measured. The ballistic pendulum would probably give the best results if the block was shielded from the action of the wave of condensed air which accompanies the projectile.

Further, E. Mach has attempted to compare the velocity of the report of a gun with that of the projectile. In one series of his experiments, when the terminal velocity of the projectile was higher than the normal velocity of sound, the time of flight of the projectile, and the time in which the report of the gun traveled over the same distance, agreed very closely. But in another series, where the terminal velocity of the projectile was below that of sound, it was found that the time of flight of the projectile was greater than that of the report of the gun over the same distance. It was therefore considered that the report of the gun travels at the same velocity as the projectile so long as the velocity of the projectile is greater than that of sound.

But when the velocity of the projectile is reduced by the resistance of the air below the velocity of sound, then the report of the gun travels in advance of the projectile, moving with the normal velocity of sound. As experiments are frequently made with velocities of the projectile more than double that of sound, there seems to be no difficulty in the way of deciding whether the report of a gun travels at the same velocity as the pro-

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* Aus den *Sitzungsberichten d. kais Akademie d. Wissenschaften in Wien:*

1, "Photographische Fixirung der durch Projectile in der Luft eingeleiteten Vorgange," von E. Mach und P. Salcher. 1887.

2, "Ueber die Fortpflanzungsgeschwindigkeit des durch scharfe Schusse erregten Schalles," von E. Mach. 1888.

3, "Ueber die in Pola und Meppen angestellten ballistischphotographischen Versuche," von, E. Mach und P. Salcher, 1889.

4, "Ueber die Schallgeschwindigkeit beim scharfen Schuss nach von dem Krupp'schen Etablissement angestellten Versuchen," von E. Mach. 1889.

5, "Opitsche Untersuchung der Luftstrahlen," von E. Mach und P. Salcher. 1889.

6, "Weitere ballistisch-photographische Versuche," von E. Mach und L. Mach. 1889.

7, "Ueber longitudinale fortschreitende Wellen im Glase," von E. Mach und L. Mach. 1889.

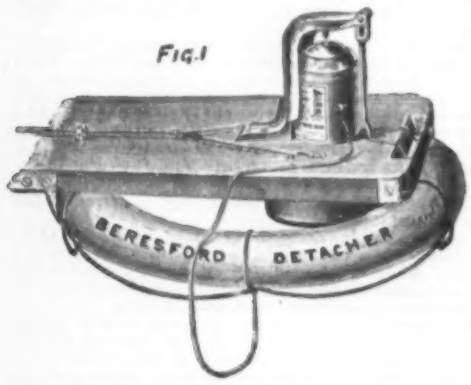
8, "Ueber die Interferens der Schallwellen von grosser Excursion," von E. Mach und L. Mach. 1889.

jectile for high velocities. If so, as appears probable, there arises the question as to the velocity with which the report of the gun travels in various directions from the muzzle of the gun. If a stretched membrane could be made to interrupt a galvanic current for a moment on the passage of a sound wave, it would not be difficult to determine the law of propagation of the report of a gun in all horizontal directions. For the projectile might be made to cut equidistant screens, and if lines of properly prepared membranes, at the same distance apart as the screens, were run in various directions, each line being provided with its own galvanic current and marker, the progress of the projectile and of the report of the gun in the chosen directions might be registered on the surface of a cylinder rotating with a known velocity. B.

IMPROVED LIFE BUOY.

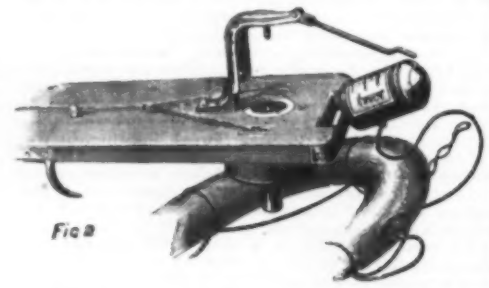
THE apparatus we here illustrate is designed for saving life at sea by instantaneously disengaging a *life buoy* with a Holmes flag brand inextinguishable self-floating *rescue light* attached, in such a manner that the operation of releasing the life buoy at the same time automatically perforates the rescue light, and of course indicates the position of the buoy.

Fig. 1 shows the apparatus ready for use. The life



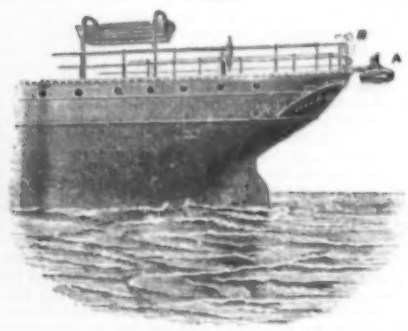
buoy is held in position by a loop threaded round the disengaging rod and supported on the other side by two brass hooks. The flag brand rescue light is seen in position and attached to the life buoy by a cord, and the disengaging wire cord is shown, which may be led from the detacher to any desired part of the vessel. Fig. 2 shows what takes place when the cry is raised of "Man overboard!" The apparatus being fixed at say the ship's stern, and the releasing cord led on to the bridge, the cord is no sooner pulled by the officer in charge than the life buoy with its rescue light attached is instantly floating astern. As we have already said, the moment this light touches the water it bursts into a brilliant flame, which continues burning for about an hour, and indicates to the submerged man or the rescue crew the position of the life buoy.

It would be difficult to overestimate the great advantages this simple but most effective apparatus renders to the object for which it is designed. Supposing a man was to fall overboard from the bows or the port or starboard sides of a steamer or sailing ship, the usual cry being raised, the officer on the bridge at once disengages the buoy and light, and by the time the man reaches the stern of the vessel, some two or three seconds, there is the means of saving his life, even if he cannot swim, within his reach. At a 16-knot speed



an elapse of say six seconds means that the buoy will be in the water at a distance of about 45 yards from the place where the man fell. Of course a less speed would mean a speedier rescue.

Fig. 3 shows the Beresford detacher in position and ready for use. Fig. 4 is a section of a Holmes flag brand inextinguishable self-floating rescue light, the invention of Mr. Joseph Holmes, who is the original introducer of the first inextinguishable light that bears his name. A is the tube up which, after automatic perforation, the water enters on the light striking the sea. B is a return covered tube to prevent the escape of the generated gas except through its proper channel. C is a perforated disk to insure direct and complete contact of chemical with inflow of water throughout. D is the chemical which revolves the gas as generated by the water. E is the outside can containing the whole. F is the flotation chamber. H the copper caps containing the oxygen ingredient which, on becoming heated by the passing flame, increases its brightness and lengthens its duration of burning.—*Marine Engineer.*



ITALIC types were shown in an edition of Virgil, in 1501. They were cut for Aldus Manutius, in imitation of the handwriting of Petrarch, by a distinguished goldsmith, Francesco Raibolini. For this new style of type Aldus was granted a patent by the senate of Venice and by three popes of Rome.

THE SPARROW'S POINT MARINE PLANT OF THE PENNSYLVANIA STEEL COMPANY.

A REPRESENTATIVE of the Baltimore *Sun* recently visited the ship yard of the Pennsylvania Steel Company at Sparrow's Point, Baltimore, Md., and from his description of the plant we have made the following condensation:

As an introduction to a description of the ship yard it is interesting to mention that there are two blast furnaces in operation, producing 500 tons of pig iron daily.

Two others are soon to be "blown in," which will increase the daily output of iron to 1,000 tons, to be converted into steel. In building a ship the first process is to make working drawings of the vessel to be built.

This is a separate department, and is under the immediate supervision of the superintendent of the works.

The office building, where this work will be performed, is nearly ready. It is a handsome hip roof building of brick, laid in black mortar, and resting on a stone foundation. The ground floor rooms will be occupied by the clerical department. On the second floor will be the superintendent's office and the room for the marine draughtsmen. The building is 100 ft. long and 40 ft. wide. It will contain also a large and neatly fitted up model exhibition room, and comfortable and commodious apartments for inspectors of vessels in course of construction. On the third floor is to be a photographing room, where all the working plans will be photographed and where negatives of pictures showing progress on ships at different stages of the construction will be developed.

The next stage of progress is the fashioning of the material for the ship's hull, which consists of keel, frames, floors, beams, keelsons, and other angle bars, water-tight bulkheads, decks, shell and other plating. To do this a great tool shed, the principal building in size and importance, has been built. It is ready for its tools. The building is a frame superstructure covered with corrugated iron. It is 435 ft. long and 140 ft. wide. It is intended to make the house as long again. A temporary end closes up the southern extremity, where the building will be extended when the demands of the business require it. In this building are to be the most modern tools, all of which have been ordered. They have all been completed or are nearing completion. There are included in the outfit punching and shearing tools sufficient in capacity to take in all classes of work. The arrangement of the machinery will be such that from the time the material is taken from the track its progress will be straight ahead until it reaches the ship. This shed is divided into three sections. First is the furnace section, where will be the double-end bar and plate furnaces. The second is the angle section, in which are punching and shearing machines. A special tool in this section will be the frame-beveling machine, which among other great advantages over the old style of beveling does not leave the bars hollow. Beside the beam forges there will be a handy little steam hammer.

The third section is the plate finishing department. Here will be four radial countersinking machines designed by the company, and two double-end planing machines capable of planing one side and one end of a plate at the same time. The planing machines have the capacity of four ordinary planers. They were manufactured by Hilles & Jones, of Wilmington.

Another special tool is a plate mangle for straightening "buckled" plates, an operation which is commonly done by hammering, and which will avoid the hammer marks on the plates. The next two tools are the hydraulic keel plate and garboard strake bending machine and hydraulic manhole punch. The latter is capable of punching out manholes over two feet in diameter. It makes the hole complete and saves the after labor of chipping left by the old process.

In the same section are to be the anglesmiths working on beam knees. Then there will be a steam saw and beam squeezer and a number of drilling machines. The beam squeezers are used to give the beams the necessary camber. A special set of tools has been provided for making steel masts. At the south end of the shed are also the furnaces and bending slabs for frame bending and plate setting and two very large scrieve boards. There are to be four radial drills, taking in a radius of 6 ft. 3 in. These will be placed in a line, and are used for drilling forgings, stern frames, keel bars, and stems.

There is also to be a complete system of traveling cranes overhead. Outside the building the plates are transferred from the cars and stacked by a powerful traveling crane running the whole length of the shed. From the shed to where the ship is building the material will be transported in cars over a narrow gauge railroad and hoisted on board by special appliances. There is also to be an unusually powerful and useful plate roller. It will be driven by an independent engine with a special arrangement for raising and lowering the top roll. All the principal tools in this shop are to be fitted with independent engines, thus saving shafting and belting. The company is making provisions for manufacturing its own rivets. With this purpose in view, store rooms occupying a space of 70 ft. by 25 ft. have been partitioned off at the north end of the tool shed. In one portion will be a rivet store fitted with bins. These will be kept filled by two rivet-making machines. Next to this will be a tool-distributing store, from which the workmen will receive their tools dressed ready for using. The company will have duplicate sets of all hand tools, so that when one set gets dulled the workmen will turn them in and receive fresh tools, enabling them to go ahead with their work without being compelled to wait while the dull ones are sharpened. Adjoining the tool store is to be a tool-dressing room, containing grindstones and emery wheels, and a turning lathe for keeping the punches, etc., in order.

Next comes a large blacksmith shop, also of frame and corrugated iron. It is north of the tool shed, and is 200 feet long by 70 feet wide. It also is finished and will be equipped wth a variety of steam hammers, from very light ones up to the four-ton hammer. Very large, powerful blowers have been fitted and terra cotta pipes placed under ground to convey the blast to the furnaces. A little north of this is the power house, of brick, where the motive power for running the machinery will be generated. This building is already supplied with two Babcock & Wilcox boilers, which have been generally adopted by the company in supplying power to all their extensive works on the point.

After the material for the hull of the ship is ready there must be places for putting the ship together.

These are known as building slips. There the keels are laid, the frames are set up and the plates are riveted to the skeleton work, piece by piece, until the hull has grown into a complete and shapely mass ready for launching, and lacking only the vitals that give her the moving force. Abundance of room has been assigned to excellently arranged building slips.

There will be eight of them, capable of laying down vessels of from 350 to 600 feet in length. Four of these slips, known as A, B, C and D, are almost finished. The others will be pushed after the yard gets into operation.

Another important building is that for the woodworkers' department. This is two stories, and is to be built of brick. It is 184 feet long by 63 feet wide, with a wing 75 feet by 21 for spar making. Only the stone foundation of this shop is completed. The first floor is to be set apart for the carpenters and the second floor will be for the joiners. The building will be fitted with a complete outfit of woodworking machinery of the latest pattern.

There are to be two extensive "fitting-out" docks, one of which is nearly done. On the largest dock arrangements have been made for erecting the shear legs, that will be capable of lifting one hundred tons.

These fitting-out docks are where the ships will go after being launched to receive their boilers and machinery, masts and spars, and other interior appurtenances. On a wharf between the two docks is to be built a substantial building 200 feet long by 127 feet wide. This is to be filled with an assortment of tools suitable for marine engine and boiler making of all sizes and types. The joiners' shop has been placed in close proximity to the docks, so as to facilitate the fitting-out operations. A paint store, 100 by 40, is easily accessible also, but a safe distance from other buildings in case of fire.

Liquid fuel is going to be extensively used in furnaces and forges. The water supply is obtained from artesian wells, and the workmen will be liberally supplied with drinking fountains.

The company's property embraces twelve hundred acres, with seven miles of water front. In planning and equipping this yard the plans for all the buildings were designed with a view to increasing them to double their size and capacity. Plans are also on foot for building a dry dock capable of receiving a vessel 600 feet long. This dock will bound the yard on the north. The situation of the yard is an advantageous one for the purpose. The water front is spacious, and vessels can be launched straight ahead with nothing in the way to impede them after they strike the water.

The officials of the ship yard are: Mr. Frank B. King, superintendent; Mr. L. H. McMurtrie, head foreman shipbuilder; Mr. G. M. Andrew, head foreman machinist; chief draughtsman, engineering department, Mr. Henry Magoun; shipbuilding department, Mr. William Gatewood.

SEVERAL correspondents of the *Lancet* have recently reported some unusual urinary troubles consequent upon eating ordinary rhubarb, or pie plant as it is occasionally called. The symptoms are frequency of micturition, hæmaturia, dysuria, and lumbar pains. This effect of the rhubarb seems dependent upon the use of hard water for drinking purposes, the oxalic acid of the rhubarb combining with the calcium in the water and forming numerous small crystals of oxalate of calcium that—it is suggested—lacerate the uriniferous tubules in passing through them. Similar consequences have been noted after eating gooseberries and acid apples; and an explanation of obscure urinary troubles in localities where hard water is used is thus afforded.

CHEST DEVELOPMENT IN YOUNG PERSONS.

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IN the perfection of modern educational methods, the physical needs of the individual have been almost entirely ignored. Facilities for the acquirement of strength and endurance have been, to a great degree, wanting. Teachers have, as a rule, possessed no knowledge of the laws of physical growth and development, and consequently the student who desired to perfect himself physically was obliged either to exercise according to his best judgment, which is bad, or to put himself under the care of incompetent instructors, which is even worse. The past few years have, it is true, given us gymnasia and various apparatus for physical development, but have they been properly used? Evidently not. In the report of the commissioner of education for 1889, that official regrets his inability to report a general adoption of physical training in the public schools, and says that "though thousands of dollars have been invested in apparatus to be used in the development of the mind, no provision worthy of serious consideration has as yet been made for strengthening the body, upon whose sound condition effective mental effort greatly depends."

It is not my intention to advance in the present paper the claims of physical education, or to illustrate the definite and remarkable results of judicious and persistent exercise. I prefer rather to bring to the attention of parents, teachers and others but one phase of the question, which seems to me to outrank all others in its importance to the present as well as to future generations. The child who first enters the school room is deficient physically as well as mentally. The body is undeveloped and often unsymmetrical. There is most likely imperfect lung expansion from the very first, and, in default of any rational treatment for it, the condition becomes more and more exaggerated, until finally it is past all hope of remedy. The student may have attained a high degree of scholarship, but he has acquired at the same time a physical conformation unfit for endurance and incapable of resisting disease. Consumption destroys fully one-seventh of our population, and it is during school life that the foundations of the disease are too often laid. It is preeminently a disease of imperfect nutrition. It attacks the crippled and poorly developed lung just as certainly as it shuns the one which is fully expanded and in constant and active service. Numerous observations have established the existence of a constant ratio between consumption and deficient lung expansion. In those cases where the degree of development fell below a certain figure, chronic disease was extremely prevalent, while in the others it was of extremely rare occurrence. In view of these and other facts, it is extremely doubtful whether consumption can coexist with complete lung expansion.

The effects of this form of physical culture have been so well summarized by a recent writer that a few extracts from his article are here quoted. He states: "While it is true that many undeveloped persons enjoy fair organic health, greater respiratory and muscular power would unquestionably make such lives more effective and longer. A roomy thorax and strong heart are no mean allies in resisting the assaults of disease. A few extra cubic inches of respiratory capacity, or a small reserve of disciplined cardiac power, may suffice to determine a favorable issue in pneumonia, pleurisy or typhoid. Every inch which a man adds to his chest measure adds to the measure of his days. Physical development can, perhaps, be excessive, yet resulting injury is limited and personal, whereas neglect of bodily improvement sins against posterity." There is a great lack of information among people generally, regarding the beneficial results of such training and the amount of development which may be attained. For the information of such it may be stated that nowhere are these effects more definite and invariable. They are as capable of demonstrating as any mathematical problem, and no one need fail to secure results proportionate to the amount of labor expended. Abundant confirmatory evidence may be found in almost any work on this subject.

By one hour's daily exercise for eight months, twelve men from nineteen to twenty-eight years of age were found by Maclaren to have gained an average of two and seven-eighths inches in chest expansion, while the greatest gain in a single individual was five inches. In four and a half months, twenty-one students of Woolwich Academy, averaging eighteen years of age, gained on an average two and five-tenths inches in chest measurement, while the largest gain was five and a quarter inches. At the end of one year's steady practice, two persons, aged sixteen and twenty years, were found to have gained in chest growth five and six inches respectively. The reports from Amherst College, as reported by Dr. Hitchcock, show that the students, at the end of their four years' course, by a half hour's light exercise four times a week, gained one and twenty-one hundredths inches in chest expansion, while those of Bowdoin College, by the same expenditure of time in heavier exercises, gained in six months one and seventy-five hundredths inches. These figures not only serve to illustrate the constant and progressive growth that occurs, but they also indicate that decided improvement may be counted upon even in those who have attained or passed the age of maturity.

In order to more fully appreciate and utilize the various methods for promoting chest development, it is necessary to consider briefly some points in the anatomy and physiology of the lungs. These may be described as collections of air cells, inclosed within elastic walls composed of bones and muscles and bounded below by a strong muscular partition which forms the floor of the cavity and which is known as the diaphragm. Their function is respiration, a process by which oxygen is introduced into the body and effete material removed from the same. The respiratory act is composed of two movements, inspiration and expiration. During the first, the chest is enlarged in all its diameters—vertically, by the contraction and descent of the diaphragm, and transversely and laterally, by the rotation of the ribs upon their axes and the action of the various muscles attached to the chest walls. During the expiration the reverse occurs. The diameters of the cavities are shortened by the ascent of the diaphragm, the depression of the ribs, and the recoil of the elastic tissue of the lungs. When it is performed forcibly, several of the chest and abdominal muscles share in the act. Inspiration is an active process, and most of the force exerted is for the purpose of overcoming the resistance offered by the elastic tissues of the lungs and of the cavity containing them. Hence the necessity for muscular development in these parts. In the physiology of respiration we find many important and suggestive facts which have a direct bearing on the subject in hand.

The capacity of the lungs is about two hundred and thirty cubic inches. Of this amount of air, about one hundred cubic inches remains constantly within them and cannot be expelled. It is renewed very slowly under the laws governing the diffusion of gases. About one hundred more cubic inches is more rapidly changed, as it can be taken in and expelled by means of forced breathing. During ordinary inspiration, however, only about twenty or twenty-five cubic inches is inhaled and only about one-tenth of the whole is renewed. It has been shown, and this can be understood from the facts above quoted, that the capacity of these organs is nearly a third greater than is really necessary to support life, the surplus being held in reserve for emergencies which may arise. Hence it follows that if two-thirds or three-fourths of the lungs perform the work of the whole, there are portions which remain inactive. And such is really the case. The apices and small sections of the circumference and bases are, in many persons and by ordinary methods of breathing, very little used, and it is a most suggestive fact that these are the very portions of the lungs which are first seized upon by consumption. Mays has recently offered valuable negative proof of the above by showing that women who lace excessively, and are thus obliged to practice clavicular breathing, are remarkably free from disease of the upper thirds of the lungs.

To fully develop the chest and put into active service each individual air cell is, therefore, the object of the gymnastic exercises here described. The proper performance of the respiratory act forms the basis of all successful methods for chest development. The most careful and persistent training will accomplish little if this essential be disregarded. We cannot hope to increase the chest capacity simply by developing the muscles upon the exterior walls. These, it is true, sustain the head and shoulders, and assist in elevating the ribs, but it is really the pressure outward, exerted by the dilating air cells, which does a greater part of the work. The muscles are merely adjuvants.

There are three ways by which air may be taken into the lungs: First, by pressing the latter outward against the walls of the chest, the method most commonly practiced; second, by drawing the lungs upward by the action of the collarbone and shoulder blades; and third, by contracting the diaphragm and abdominal muscles, and allowing the lungs to dilate from their bases upward. This latter is the only true method of breath taking, and should be thoroughly mastered before proceeding further. It is, perhaps, unnecessary to state that in this, as in all other gymnastic exercises, the clothing should be loose and free about the waist.

Begin as follows: Stand erect and with head and shoulders drawn well backward. Expel all the air from the lungs by contracting the chest and abdominal muscles. Next, holding the chest quite immovable, allow the air to enter the lungs by the action of the abdominal muscles alone. If properly performed, the first movement will be of a protrusion of the abdomen and an increase in the transverse diameter of the lower portion of the chest. Inhale, at first, only a moderate amount of air, but gradually increase the depth of the inspiration until you become proficient in the exercise. Remember that the protrusion of the abdomen and the expansion of the chest occur almost simultaneously during each inspiration. Having filled the lower portion of the lungs in the manner described, the first two methods above noted may be employed to distend the apices. By the abdominal method, the expiratory act is much better regulated, more easily controlled, and is performed with the minimum degree of muscular effort. For these reasons, it forms a prominent part in all kinds of vocal culture. The accompanying diagram illustrates the antero-posterior

enlargement of the chest produced by this method alone. The heavy lines show the contour of the chest after a full inspiration.

One of the more simple exercises is what is known as forced voluntary breathing, practiced, of course, after the method above described. Stand erect, and then take slowly a series of deep inspirations. Then take a long breath and hold it as long as possible. By a little practice this period may be easily increased from thirty seconds to a minute and a half. Repeat until the lungs feel a little tired. Again take a deep inspiration, and then count in a loud voice as long as you can. One should be able in a few days to reach as high as seventy-five. Exercises such as these will also test your proficiency in abdominal breathing.

Among the out-door resources, running and walking occupy a justly prominent place. Unlike some of the other exercises, they act upon the lungs indirectly by increasing the demand for oxygen on the part of the tissues. While at rest the amount of air used by the lungs per minute is about 430 cubic inches; while walking at the rate of four miles an hour, 2,200 cubic inches; and while walking at the rate of six miles an hour, 3,200 cubic inches. Thus, by the increased depth and rapidity of the inspirations, these is a prompt renewal of the residual air and an expansion of the less used portions. As ordinarily practiced, these exercises will sometimes fail to produce satisfactory results. Success here, as well as elsewhere, depends in great part upon attention to details. Hence the blame, if any is attributable, lies to the exercises rather than to the method.

Particular attention should be given to the position of the shoulders and chest, and the one exercising should inhale large amounts of air slowly rather than small quantities at frequent intervals.

The novice who attempts to run any considerable distance soon finds himself out of breath. The respiration becomes short and labored, the pulse rapid, and a sense of extreme exhaustion is promptly experienced. Thereupon the rate of speed naturally becomes lessened, during which time a reciprocal action becomes established between the heart and lungs. The more remote portions of the latter become distended, and thus the increased circulation of blood through the air cells can be provided for, thereby lessening the strain upon the heart and blood vessels, and permitting thorough oxidation. Now, under rational methods of training, these phenomena should never occur. The lungs should be equal to all the ordinary demands made upon them, and it is the fault of the individual if they are not. While brisk walking is allowable, fast running is not. All competitive effort, and all attempts to break a record, are disastrous as regards the objects you are striving to attain. After acquiring as great a walking speed as is consistent with a graceful and easy carriage, begin the running exercise, gradually increasing the distance, but not the rate of speed. A five-mile gait is quite sufficient, and a healthy person in good form ought to cover two or three miles easily and without experiencing at any time any marked shortness of breath or sense of exhaustion. This result can be easily secured by persistent practice and careful attention to the foregoing suggestions.

The success of any method of training depends not only upon its inherent worth, but upon the ease and readiness with which it can be put into practice. Gymnastic apparatus is not accessible to the masses, while of those having access to the ordinary gymnasium, but a very small proportion make good use of their opportunities. As regards children, there is absolutely nothing at their disposal. There is demanded, therefore, something which may be always at hand, which is applicable to all ages and thoroughly adapted to the end in view, which is in every particular harmless to the exerciser, which can be used several times daily, and which of itself possesses a sufficient element of interest to insure its long-continued use.

While the varied results of physical training are to be attained at any time prior to middle age, yet the degree of development bears a close relationship to the age of the individual. After the age of fifty, for example, very little increase of lung capacity can be expected; yet, even here, I have noted a decided improvement in the contour of the chest, as well as the acquirement of increased respiratory power. It is during childhood, however, that the greatest successes of physical culture are to be noted, and it is not difficult to understand why this should be the case. All the conditions are at that time favorable for development. The bones and cartilages forming the framework of the chest contain a minimum amount of earthy material, and consequently are extremely pliable. The muscles are undergoing a formative process, and consequently are readily responsive to stimulus and capable of attaining a higher degree of development than at any other time.

The following table, compiled by Roberts, shows excellently well the progressive increase in the circumference of the chest as it occurs normally and without the aid of gymnastic exercise.

Age—Years.	Chest Girth.	Annual Rate of Growth.
	Inches.	Inches
10	23·77	0·30
11	24·33	0·56
12	24·81	0·48
13	26·30	1·49
14	28·18	1·88
15	29·70	1·52
16	31·19	1·49
17	32·80	1·71
18	34·03	1·23
19	34·76	0·73
20	35·13	0·37
21	35·42	0·29

Here it is shown that, although there occurs a progressive growth from early childhood, the greatest increase takes place between the thirteenth and eighteenth years. The increase in height and weight, however, is noted for several years longer. There are other observers who maintain that the lung capacity is increased from the fifteenth to the thirty-fifth year, and at the rate of five cubic inches a year, while after the latter age it diminishes about one and a half cubic inches a year.

Sex exercises some little effect upon growth and development. The investigations of Bowditch have shown that until the age of eleven or twelve years, boys are both taller and heavier than girls of the same age. At this period girls begin to grow rapidly and surpass boys of the same age, in both these particulars. Boys afterward acquire and retain a size superior to that of girls, who have now completed their full growth.

The period of greatest growth is, as a rule, the one most favorable to lung expansion. Hence it follows that between the ages of ten and twenty-five years there is an important interval during which physical development of all kinds may be attained in its greatest degree and with the least labor on the part of the individual. The chest girth of 35·42 inches, as given in the above table, is, therefore, much less than might have been attained had proper chest exercise been employed during the period indicated.

The age at which such exercises should be undertaken depends, of course, upon the condition and surroundings of the individual. Up to ten years or thereabout, a free, active, out-door life, together with such suitable exercises as the schools *should* afford, would be amply

sufficient. Unfortunately, physical training as ordinarily employed there is a mere farce and scarcely worthy the name. The idea that ten or fifteen minutes of light gymnastics daily is sufficient to strengthen the muscles, straighten the shoulders, and develop the chest is manifestly absurd. One can hardly expect to counteract in a few minutes those influences which are at work from morning till night, or to overcome in a moment physical defects which have existed for years, and perhaps from infancy.

Physical education is deserving of as much recognition in our public schools as any other branch of learning, and not until this fact is realized can we hope to obtain for our children all the essentials of good health and longevity.

Calisthenics, as ordinarily practiced, are, as I have stated, of too trivial a character to produce any very marked results. By allowing children the use of wands or wooden dumb bells varying in weight from a half to one pound, their work is rendered more interesting, and at the same time the improvement in muscular development and conformation of the chest is much more apparent. It may be stated just here that dumb bells, as employed in youth and adult life, are much too heavy. It is seldom expedient to go above five pounds—a weight which will enable one to practice the various exercises for a long time without fatigue. As true chest developers, however, they do not compare for a moment with the weights, for although by their use the chest girth is generally increased, this is most often due to the development of the muscles on the outside of the trunk rather than to increase of lung capacity. The results, therefore, are more apparent than real.

The duration also of these school exercises should be increased. Twenty minutes' work during each of the two daily sessions is not too long, but would produce results far greater and more satisfactory than any heretofore observed.

After the age of ten or twelve years there begins another period which is perhaps more important from a physical point of view than the one preceding it. At this time specific exercises should be instituted for securing lung development. The methods for attaining this object have, I trust, been sufficiently well described. To those who can afford it—and there are very few who cannot—the chest weight offers the most efficient aid. It should be placed in every home in the land where children are, and its daily, routine use should be encouraged and, if necessary, insisted upon. It may at times prove a difficult task to persuade young persons to continue the work they have begun, yet after a habit becomes established, its importance appreciated, and its good effects recognized, all reluctance will most likely disappear.

The object of this paper is the promotion of physical culture, not simply for the improvement of the body or figure, or for purposes of competition, but for the reason that it is one of the chief measures for preventing chronic disease of the lungs. I have endeavored to show that to be most effective, it must be instituted in early life and maintained by proper means through subsequent years. Whatever may be the real cause of consumption, it has been fully established that the well developed lung invariably escapes infection, while the unexpanded one is the first to suffer. Could our educators be convinced of the vital importance of this subject, and be induced to act accordingly, the number of deaths from this disease would be materially lessened, while the capacity for study and for physical endurance would be as greatly increased. During school life the question of the child's future welfare is often decided. It is in the power of parents and teachers to secure for him either a phenomenal brain with a consumptive tendency, or a well developed mind with physical perfection. Now, which shall it be?—*N. E. Medical Month*

DR. RICHARDSON ON ALCOHOL.

DR. B. W. RICHARDSON, who is one of the ablest physicians in Great Britain, says: I became an abstainer from alcohol for the most commonplace and selfish reason in the world, the instinct of self-preservation. From a lecture delivered in one of my experimental and practical courses to medical brethren, on December 7, 1869, I infer that I had got, at that time, very near to the practice of abstinence, and quite near to the truth; for I find myself closing the lecture with the following words: "Speaking honestly, I cannot, by any argument yet presented to me, admit the alcohols through any gate that might distinguish them as apart from other chemical bodies. I can no more accept them as foods than I can chloroform, or ether, or methylal. That they produce a temporary excitement is true; but as their general action is quickly to reduce the animal heat, I cannot see how they can supply animal force. I can see clearly how they reduce animal power, and can show a reason for using them in order to stop physical pain, or to stupefy mental pain; but that they give strength, *i. e.*, that they supply material for the construction of fine tissues, or throw force into tissues supplied by other material, must be an error as solemn as it is widespread. The true character of the alcohols is that they are agreeable temporary shrouds. The savage, with the mansions of his soul unfurnished, buries his restive energy under their shadow. The civilized man, overburdened with mental labor, or with engrossing cares, seeks the same shade; but it is shade after all, in which, in exact proportion as he seeks it, the seeker retires from the perfect natural life. To resort for force to alcohol is, to my mind, equivalent to the act of searching for the sun in subterranean gloom until all is night. It is time now for the learned to be precise respecting alcohol, and for the learned to learn the positive value of one of their most potent agents for good or for evil; whereupon, I think, they will place the alcohol series in the position I have placed it, even though their prejudices in regard to it are, as mine are, by moderate habit, but confessed inconsistency, in its favor." I have heard it said many times that this was the strongest utterance I ever made against alcohol; because, when I made it, I was not an abstainer. But I have a word more to add. At the time when the lecture above named was delivered, I had looked only at the physiological side of the matter. Afterward I studied, in the same experimental way, the power of alcohol in producing disease. Thereupon I discovered that so potent is alcohol in producing structural and fatal disease, just as certainly as I could make an animal dead drunk by it, so I could conjure up organic disease to order, if I may so put it, according to my will, and almost according to fixed time and season. Also, I detected that the fatal changes were much more quickly and surely brought about than I had ever supposed possible. I was startled at what I witnessed, and, selfish-like, applied the moral. I said to myself, May be I am experimenting on myself. But why should I? "If thy right hand offend thee, cut it off," was the daily plea of conscientious knowledge; and, at length, the plea prevailing, I cut off alcohol root and branch. Then, when I found how strong and healthy I was, as well as safe, under total abstinence, I thought it my duty, even at the risk of speaking less forcibly against alcohol than I might do if I partook of it—as the spirit of evil suggested—I began and continued boldly to expound all the facts; and that is the way I became an advocate of total abstinence, as well as a total abstainer.—*Hand and Heart.*

THE SOLUTION AND REDEPOSITION OF CARBONATE OF LIME BY SEA WATER.*

IF we turn our attention to the solution of dead carbonate of lime in shells and coral skeletons by the action of sea water, it will be found that the rate of this solution varies greatly according to the conditions in which these remains are exposed to the solvent power of the water. A large number of experiments have been conducted with the view of determining the solubility of carbonate of lime under its different conditions. It may be pointed out that the normal amount of carbonate of lime dissolved in sea water is very small, strikingly so (0·1200 gram. per liter) when compared with the vast amount of this substance continually being secreted from the sea by organisms. Sea water can, however, take up 0·6490 gram. per liter of carbonate of lime in an amorphous (or hydrated) condition, forming a clear supersaturated solution, but after a time not only the excess so added is thrown down, but also sometimes a portion of that normally present in the water itself.

It would thus appear that it is unable permanently to retain in solution more of this substance than is usually found present in sea water. This peculiarity of sea water, after taking up a large amount of amorphous carbonate of lime, and throwing it out in a crystalline form, accounts for the filling up with crystalline carbonate of the interstices of massive corals in coral islands and other calcareous formations, so that all trace may ultimately be lost of their original organic structure. These experiments show a great diversity as to the amount of carbonate of lime which will pass into solution in sea water from various calcareous structures in a given time. As a rule, the more definately crystalline the substance is, the less it is soluble. Calcspar is less soluble than massive varieties of coral, and these again less than the more porous varieties. We have already indicated that amorphous or hydrated carbonate of lime is (in that condition) much more soluble than any other form of the substance. The rate of solution is also much greater when the water is constantly renewed than when the same water remains in contact with carbonate of lime. The water quickly becomes saturated and unable to exert further solvent action.

In this connection we found that different samples of sea water from different localities possessed very different solvent powers. Especially was this the case between summer and winter waters, the former having distinct solvent action on coral skeletons, while with the latter there was hardly any. The lower specific gravity of winter waters may be regarded as to some extent reducing their solvent power, but this is more probably to be attributed to the absence of free carbonic acid, *i. e.*, carbonic acid in excess of what is required to saturate the free base in the sea water as normal carbonate. To test this point, carbonic acid was added to one of these winter waters (which had no solvent action on coral), the quantity added not being sufficient to destroy its alkaline character. It was found that in these circumstances an appreciable amount had been dissolved.

This appears to indicate that there is more carbonic acid in summer than in winter waters in our latitudes, due probably to the increased activity of animal life. Mr. Buchanan's observations on board the Challenger show that the carbonic acid present in sea water, over and above that necessary to form normal carbonate of lime, is subject to great variations. It appears that this is a much more effective agent in the removal of carbonate of lime from shells, etc., than the solvent power of sea water itself (although artificial sea water quite free from carbonic acid dissolves carbonate of lime). Buchanan's observations have also shown that carbonic acid, as a rule, is more abundant in bottom than in surface waters; and Reid's experiments show that carbonated sea water under high pressure takes up more carbonate of lime than that at a normal atmospheric pressure.

The fact that carbonic acid is more abundant in deep waters is evidently connected with the respiration, and also the decay, of the animals which live and die on the ocean floor; and also with the decay of those which fall from the surface. The water filling the deeper hollows has also in its passage to the equator passed over thousands of square miles of this floor covered with living animals, and as this water has a very slow motion, and is but slowly renewed, we would expect an accumulation of carbonic acid and deficiency of oxygen in these abysmal depths. When, therefore, carbonate of lime secreting animals die at the surface of the water and their bodies fall to the bottom, the shell is exposed to solution from the action of the sea water through which it passes, and it may be to that of carbonic acid produced by the decomposition of its own organic matter. If the shell be thin, as in the case of heteropods and pteropods, it may be wholly removed before reaching the bottom, but the thicker shelled varieties tend to accumulate even in depths of 2,000 fathoms, where they are soon covered up by other shells; and being surrounded by sea water already saturated with carbonate of lime, are preserved from solution, and form vast beds of calcareous ooze.

It is found that the amount of carbonate of lime present in such ooze is greater or less according to the depth of water through which the shells pass from the surface to the bottom, and also to the slow renewal of the water in contact with these great lime deposits. In the red clay area the carbonate of lime is almost entirely absent. The deeper waters which cover such areas are more active in the removal of carbonate of lime, not only because of the large amount of carbonic acid they contain, but doubtless to the deoxidation of alkaline sulphates by organic matter, which gives rise to sulphuric acid, etc. At the same time account must be taken of the great pressure at such abysmal depths, and the fact that the substance of the shells being less compressible than sea water, they would fall more slowly, and hence would be longer exposed to the action of the deeper layer of water than those near the surface.

What calcareous remains do reach the ocean floor at such abysmal depths represent the hardest and crystalline varieties of carbonate of lime which resist the solvent action of sea water to the greatest extent.

In this way we appear to have a perfectly rational explantion of the partial disappearance of carbonate of lime shells from the shallower depths, and their total disappearance from all the greater depths of the ocean. It is to be observed that all those shells in which a considerable quantity of organic tissue is associated with the carbonate of lime disappear in solution more rapidly than the shells of the foraminifera, which contain little organic matter. (During the whole of the Challenger cruise only two bones of fishes, other than the otoliths and the teeth, were dredged from the deposits, and all traces of the cetacean bones were removed, except the dense ear bones and dense zyphioid beaks.) The remains of crustacean animals were almost wholly absent from deep sea deposits, with the exception of ostracode shells and the hard tips of some claws of crabs.

Turning now to the lagoons and lagoon channels of coral islands, it is believed that large quantities of carbonate of lime are in the same way being dissolved from these shallow basins as well as from the deposits of the deep sea, but under somewhat different circumstances. In the case of a shell falling to the bottom of the sea, it is continually brought in contact with new layers of water, which has the same effect as if a continuous stream of water were passing over the shell. In the case of the lagoons this last is what takes place. The water which flows in and out of the lagoons twice in twenty-four hours passes over great beds of growing coral, and from all the observations we have is largely charged with carbonic acid, owing probably to the large number of living animals on the outer reef over which the water passes on its way to the lagoon. This water passes continually over the dead coral and sand of the lagoon, and takes up and removes large quantities of carbonate of lime in solution (as well as suspension), for in these lagoons the spaces covered by dead coral *debris* always greatly exceed the patches of growing coral. Owing to the fact that the water of the lagoon is continually in motion and constantly renewed, the layer in contact with the bottom of coral sand can never become saturated or unable to take up more lime, as is apparently the case in the layers of water in contact with the globigerina ooze and other calcareous deep-water deposits.

From the foregoing discussion and observations it is evident that a very large quantity of carbonate of lime is in a continual state of flux in the ocean; now existing in the form of shells and corals, but after the death of the animals passing slowly into solution, to go again through the same cycle.

On the whole, however, the quantity of carbonate of lime that is secreted by animals must exceed what is redissolved by the action of sea water, and at the present time there is a vast accumulation of carbonate of lime going on in the ocean. It has been the same in the past, for with a few insignificant exceptions all the carbonate of lime in the geological series of rocks has been secreted from sea water, and owes its origin to organisms in the same way as the carbon of the carboniferous formations; the extent of these deposits appears to have increased from the earliest down to the present geological period.

At the present time most of the carbonate of lime carried to the ocean by rivers has been directly derived from calcareous stratified rocks formed by organic agency in the sea in earlier geological ages, but the calcium in these formations was, in the first instance, derived from the decomposition of the lime-bearing silicates of the earth's original crust, and this decomposition, which is still going on in the sea and on the land surfaces, is a continuous additional source of carbonate of lime.

In considering the analyses showing the average composition of sea salts, one is struck with the relatively small quantity of those very substances which are extracted so largely from sea water by plants and animals, viz., carbonate of lime and silica. Siliceous deposits are of vast extent, yet silica occurs merely in traces in sea water; carbonate of lime deposits are of vastly greater magnitude, yet carbonate of lime makes up only $\frac{1}{7\frac{1}{2}}$ part of the saline constituents of sea water, and only $\frac{1}{27\frac{1}{2}}$ part of the whole bulk of sea water. Sulphate of lime is ten times more abundant than the carbonate in sea water; on the other hand, the river water that is poured into the ocean contains about ten times as much carbonate as it does of sulphate of lime.†

The total amount of calcium in a cubic mile of sea water is estimated from analyses to be 1,941,000 tons, and the total amount of calcium in the whole ocean is calculated at 628,340,000,000,000 tons. The total amount of calcium in a cubic mile of river water is estimated at 141,917 tons, and the total amount of this element carried into the ocean from all the rivers of the globe annually is estimated at 925,866,500 tons. At this rate it would take 680,000 years for the river drainage from the land to carry down an amount of calcium equal to that at present existing in solution in the whole ocean. Again, taking the Challenger deposits as a guide, the amount of calcium in these deposits, if they be 22 feet thick, is equal to the total amount of calcium in solution in the whole ocean at the present time. It follows from this that if the salinity of the ocean has remained the same as at present during the whole of this period, then it has taken about 680,000 years for the deposits of the above thickness, or containing calcium in amount

* From a paper by Messrs. J. Murray and R. Irvine, read before the Royal Society of Edinburgh.

† Murray, "Total Rainfall of the Globe," *Scot. Geogr. Mag.*, 1887.

equal to that at present in solution in the ocean, to have accumulated on the floor of the ocean.

From the data here furnished a number of other interesting speculations might be indulged in, relating to the amount of carbonic acid that has been abstracted from the atmosphere and fixed in carbonate of lime deposits: the total amount of disintegration of lime-bearing siliceous rocks measured in terms of the calcium at present existing in solution in water and fixed in calcareous deposits; the relative proportions of substances secreted from the ocean as compared with other materials derived from the direct disintegration of the land-forming deep sea deposits; and the apparent accumulation of carbonate of lime formations toward the equatorial regions of the globe.

THE GLOW OF PHOSPHORUS.

A LECTURE on this subject was given not long ago at the Royal Institution by Professor T. E. Thorpe, who began with a notice of an ancient use of the term phosphorus in a general sense to denote any substance which glowed in the dark, just as the word phosphorescence is still employed. He alluded to the various phenomena of this description which had been known from very early times, and which occurred in the animal, vegetable, and mineral kingdoms. Glow worms, fireflies, fungus on decaying tree stumps, were examples in the two former, and in the latter, besides certain gems capable of shining by their own light, the sulphides of the alkaline earths were prominent for this property. In the seventeenth century it was known that barium sulphate, when ignited with white of egg and other carbonaceous materials, produced a kind of "phosphorus." The sulphide of calcium, now so well known as "luminous paint," was first produced by Mr. Canton by igniting a mixture of oyster shells and sulphur. The singular property possessed by these alkaline earth sulphides of absorbing light when exposed to it, and emitting it again afterward, is not due, so far as we know, to any chemical change in their composition.

Their phosphorescent properties are in some cases enhanced by warming, and suspended by cooling. In others the converse is true, the phosphorescence disappearing on heating, but reappearing on cooling. The real source of light is not the calcium sulphide, this substance when quite pure not being phosphorescent, but resides in adventitious matters which are present.

A great variety of color is attainable according to the nature of the substances present, traces of bismuth, antimony, tin, copper, gold or zinc giving blue or violet tints, while manganese imparts a purplish and lead a yellowish green hue. Examples of substances exhibiting phosphorescence when heated were shown by sprinkling a variety of dolomite, which glowed with a red color, and flourspar, which shone blue green, on a hot plate. Other examples were enumerated, such as the light emitted by mica when split along its cleavage planes, that observed in the crystallization of some salts, the light emitted by mercury impinging on a bell jar in a partial vacuum and which can also be seen in a Sprengel pump, and the glow produced by electrical discharges in highly vacuous tubes. Many very beautiful illustrations were shown of the glow emitted by various substances, such as fluorspar, zinc sulphide, rubies, diamonds (which become gradually converted into graphite by the process), pure alumina, etc., when submitted to molecular bombardment in a high vacuum by passing an electric current.

The lecturer then proceeded to the discussion of the element to which the term phosphorus is now restricted, describing it as the most remarkable of all the elementary substances known. He quoted many of the observations of Boyle, who noticed that it was only luminous in presence of air, the character of the light and the effluvia accompanying it, the odor of the water in which it was kept, that it was soluble in oils, but that certain oils prevented the glow. In the *Philosophical Transactions* it is stated by Dr. Scherer that the glow of phosphorus is increased when the air is rarefied, but on the other hand it does not glow in a Torricellian vacuum. It was shown also by Lavoisier that it is not possible to ignite it with a burning glass in a barometric vacuum. The glow is evidently due to oxidation, and yet phosphorus does not glow when immersed in pure oxygen at ordinary pressure instead of air. When warmed, however, or when the oxygen is rarefied, the glow appears, and conversely it ceases to glow in air when the latter is condensed. John Davy, brother of Sir Humphry, showed that phosphorus just ignited in ordinary air could be extinguished by suddenly compressing the air, and recently Brereton Baker has shown that it does not glow or burn in absolutely dry oxygen under any conditions. Graham found that minute traces of many substances, *e. g.*, turpentine and ether, were sufficient to prevent the luminosity. It is known that ozone is produced whenever phosphorus glows, and it appears that if the conditions are such that no ozone can be formed, there is no glow. No ozone is ever produced in the presence of essential oils, and there is no glow in their presence. A speculation of the lecturer's to account for the formation of ozone was that in the formation of P_2O_5 a molecule of oxygen is necessarily separated into its constituent atoms, and that one of these unites with another molecule to form ozone, thus:

$$P_2 + 3O_2 = P_2O_5 + O; \quad O + O_2 = O_3$$

The maximum glow, and maximum formation of ozone, take place at 24° or 25° C., and although the glow is extinguished by immersion in oxygen, the introduction of a little ozone causes it to reappear. The reason the luminosity and formation of ozone increase with the temperature is probably that these effects are due to the oxidation of phosphorus vapor, which, of course, is given off more freely at higher temperatures, although at ordinary temperatures a good deal volatilizes, as is shown by the fact that notable quantities of phosphorus are carried off in the state of vapor by inert gases, such as hydrogen. The lecturer has recently been working on the products of combustion of phosphorus in a limited supply of air, and found that when it was strongly heated an intermediate oxide of phosphorus P_2O_4 was produced. A crystalline deposit was also noticed on the tube in which the experiments were performed. This was very volatile, readily melting by the heat of the hand and darkened by the action of light. The substance is obtained with some difficulty by allowing the P_2O_3 and vapor of phosphorus to condense in the cold part of the tube, and passing the uncondensed vapor into a receiver kept cold by a freezing mixture. It turned out on examination to be what has hitherto been supposed to be P_2O_3, but this probably does not exist, the true formula, as shown by its vapor density, being P_4O_6, corresponding with the corrected formula As_4O_6 of arsenious oxide. The P_4O_6 melts at 23° C., and distills easily without decomposition, but is decomposed by the action of light with liberation of free phosphorus.

It slowly absorbs oxygen, forming P_2O_3, and the P_2O_3 is found to be in crystals, proving that the P_4O_6 is in the state of vapor when it combines with the oxygen. It is readily soluble in benzene and carbon bisulphide, but not at once in water. When thrown into water it sinks to the bottom and remains unchanged for many days.

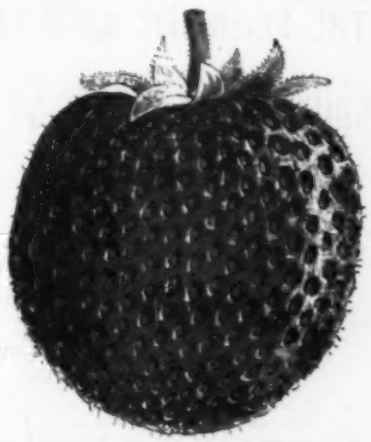
When gently heated it ignites, and when thrown into chlorine at ordinary temperatures it also takes fire. When thrown on to the surface of alcohol it inflames, and when the action on alcohol is moderated and kept under control, the product of the reaction is the third and hitherto unknown phosphorus ether

$$P\begin{cases} OC_2H_5 \\ OC_2H_5 \\ OH. \end{cases}$$

The other two previously known being $P(OC_2H_5)_3$ and $P(OC_2H_5)_2(OH)$. P_4O_6 shows exactly the same phenomena with respect to luminosity as phosphorus itself, the glow being modified in exactly the same way by similar conditions, and the glow of phosphorus was probably caused by its oxidation to P_2O_3 and P_4O_6 with production of ozone, and the reaction of ozone on the vapors of P_4O_6 and phosphorus.

NEW STRAWBERRIES.

MR. LAXTON can illustrate his admirable paper on "seedling strawberries" by the interesting results of his labors as a raiser. Although he produces a vast number of seedlings, he is prudent as to what he keeps, that he may add nothing to the lists that shall be other than creditable. There has been much said about Noble, but it has admirably maintained the character we gave it on its first appearing. That it is wanting in flavor is admitted, but where an abundance of early and handsome berries are required, Noble must lead the way with prudent men for the present, and probably for many years to come. The few who complain of lack of flavor are outvoted by the many who recognize the immense value of an early gathering and a full basket.



NEW STRAWBERRY—COMPETITOR.

NEW STRAWBERRY—LATEST OF ALL.

A highly promising novelty is Competitor; which ripens as early as Noble, but is larger, of finer flavor and appears likely to answer well in cool aspects as a second early, the appearance and flavor rendering it a proper "competitor" with the favorites that are highly flavored. This variety is the offspring of the American Kerr's Prolific, fertilized with the pollen of Forman's Excelsior. The plant is vigorous and prolific; the fruit globular and flattened or slightly conical, the color brilliant scarlet.

Cardinal is a second early; the fruit large, conical; the color scarlet; the flavor characterized by a peculiar sweetness. Appears to have a touch of the Chilian in its constitution

White Knight, a mid-season fruit, is a seedling from Noble, fertilized by pollen of King of the Earlies. It is peculiarly distinct, the fruit large, conical, the color light scarlet around the crown, the remainder white. This has a hautbois flavor, but more piquant. It will be an interesting companion strawberry to the Bicton Pine, as by a little shading it may be ripened wholly of a white color.

Latest of all is a seedling from British Queen, fertilized by pollen of Helena Gloede. The fruit is very large, cockscomb shaped; the flesh white, with rich vinous flavor. The plant is robust, with thick, leathery foliage. The flowers are larger than those of any other variety, and the fruit ripens ten days later than that of British Queen. Mr. Laxton considers that this will prove of the greatest value to market growers.

Albert we have not seen. Mr. Laxton describes it as a good grower, and abundant bearer; the fruit large, glossy scarlet; very rich in flavor, and somewhat piquant.—*The Gardeners' Magazine.*

THE FOOD OF THE BIRDS.

By Rev. H. A. MACPHERSON, M.A., M.B.O.V., etc.

1. THE nightingale subsists almost wholly, if not entirely, on insects. The lesser whitethroat, blackcap, and some other warblers are fond of fruit; but not, I think, the nightingale. It is extremely fond of the larvæ of the common wasp.

2. The titmice feed principally on insects, but the crested and coal tits are partial to fir seeds. The seeds of the common sunflower are eaten greedily by the great tit. The marsh tit (in common with the goldfinch and linnet) is partial to the seeds of the thistle family. I have seen longtailed titmice feeding on "looper" caterpillars, and Dr. Girtauner contributed to Dresser's "Birds of Europe" a charming account of birds of this species, which he fed in confinement on plant lice.

3. Greenfinches feed on the seeds of many so-called weeds. On the other hand, I have seen them gathering turnip seed almost as fast as it was sown, such numbers being present as to be undoubtedly injurious to the interest of the farmer.

4. Thrushes are also deadly enemies of garden snails.

5. All the warblers will take insects. I once found a male blackcap full of ladybirds. The thorough way in which this species will clear the elder bushes of their berries in autumn is diverting. Near Montreux, I have seen long rows of the bushes thus treated.

6. The redbacked shrike certainly kills young birds, but it also kills field mice. It subsists chiefly on Coleoptera, bumble bees, and other insects, which are deftly impaled on convenient thorns. In Mr. Pidsley's forthcoming "Birds of Devonshire," I have recorded how on one occasion I observed a whole family of this species glutting their appetites on caterpillars (of a Vanessa), which were bolted whole.

7. The hawfinch is undoubtedly injurious to green peas. On the other hand it consumes many caterpillars. In 1887, Mr. Bartlett, the Curator of the Maidstone Museum and a well known naturalist, dissected several hawfinches, killed in May and June. All of these poor birds contained green caterpillars. In one case, a female bird proved to have swallowed no less than forty of these larvæ.

8. The bullfinch consumes the seeds of dock, plantain, and other undesirable weeds. Its presence is a benefit to us during all but the spring months, when it should be scared from orchards.

9. Nuthatches certainly take nuts, and beechmast also. But they subsist on insects all the summer. A female in my possession used to take bluebottle flies from my fingers with avidity. Woodpeckers are far more than merely "innocuous." They are the forester's best friends; their wanton destruction is one reason why many plantations are destroyed by boring beetles.

10. Wagtails and pipits are chiefly insectivorous, but buntings are so in a very limited degree. I admit that both the snow bunting and Lapland bunting will eat insects in summer, and the common bunting is partial to beetles. But the latter species does some harm to ricks when too numerous. Yellow buntings are fond of blackberries. Ciri buntings cannot thrive long without insects.

11. That the sparrow should be exterminated ruthlessly everywhere I quite admit. I should like to see a sparrow club in every parish in England, and to hear that a vigorous crusade was sustained. But it is fond of insects. It is very fond of house flies, frequently kills the white cabbage butterfly, and I saw one ambitious bird make repeated swoops at a fine swallowtail (Machaon).

12. The starling is most useful, but it interferes sadly with woodpeckers, and should be kept within reasonable limits. At present it is increasing so fast that in a few years it must become sadly injurious, I fear.

13. The rook has increased so disproportionately of late as to become a great nuisance. I think a tax should be placed on rookeries. The quantity of corn that this species destroys is out of all proportion to the value of its services in killing grubs; its numbers being in many districts legionary, it has become as injurious to game preservers as the carrion crow.

14. The pied flycatcher feeds largely on caterpillers. Some young birds which I sent to the South Kensington Museum contained small beetles and tiny caterpillars. If space permitted, I could testify to the value of the spotted flycatcher, which feeds on the yellow underwings and other moths.

15. Chaffinches sometimes pull up young radishes. They consume large quantities of insects. I once saw an old female bring an enormous earthworm to one of her nestlings.

16. Of the Corvidæ, the raven is a bit of a poacher, and injurious to the sheep farmer, but it is a useful scavenger. The hooded and carrion crows are sad rascals, but they swallow mice and other vermin. The jay steals eggs, but it lives largely on snails, and I have found its stomach crammed with large beetles.

17. Owls are certainly the farmer's friends, and pole traps are largely to blame for the plague of rats which we hear so much of nowadays. Kestrils consume many mice. I have not space to speak of the other Falconidæ, but *en passant* the merlin swallows earthworms, and the persecuted peregrine sometimes lunches on such an unimportant trifle as a skylark, as I pointed out recently in the *Field*.

18, 19. These require no comment, except that Mr. Gurney has found that the nightjar sometimes swallows vegetable substances (as does the cuckoo).

20. Crossbills do not live exclusively on the seeds of conifers, as Mr. C. Parkinson seems to suggest. They feed on insects also. Both the late Dr. Saxby and myself have recorded our observations of crossbills feeding on aphides; other evidence of a similar kind is forthcoming.

21. Wood pigeons are at once injurious and beneficial. They require to be kept within moderate limits, and then they do good.

22. The cornerake subsists on slugs, and insects of various kinds; a useful bird.

23. The siskin "cannot do much damage." I should like to know any damage done that can be laid to the share of this charming finch. It feeds, like the goldfinch, on insects, as well as on grass and other seeds.

24. Any one who will take the pains to observe a pair of wheatears will find that they feed their young on caterpillars, almost exclusively.

25. The wryneck consumes ants principally. The wheatear fattens on the small beetles and other insects that are to be found about loose stones.

26. The goldcrest will take small seeds, but prefers insects. A caged bird of mine used to devour the larvæ of clothes moths with a relish.—*Hardwicke's Science-Gossip.*

[NATURE.]

THE "BARKING SANDS" OF THE HAWAIIAN ISLANDS.

ABOUT a year ago *Nature* printed my letter from Cairo giving a condensed account of an examination of the Mountain of the Bell (*Jebel Nagous*) on the Gulf of Suez, and of the acoustic phenomenon from which it is named. In continuation of my researches on sonorous sand, which are conducted jointly with Dr. Alexis A. Julien, of New York, I have now visited the so-called "barking sands" on the island of Kauai. These are mentioned in the works of several travelers (Bates, Frink, Bird, Nordhoff, and others), and have a world-wide fame as a natural curiosity; but the printed accounts are rather meager in details and show their authors to have been unacquainted with similar phenomena elsewhere.

On the south coast of Kauai, in the district of Mana, sand dunes attaining a height of over one hundred feet extend for a mile or more nearly parallel to the sea, and cover hundreds of acres with the water-worn and wind-blown fragments of shells and coral. The dunes are terminated on the west by bold cliffs (*Pali*) whose base is washed by the sea; at the east end the range terminates in a dune more symmetrical in shape than the majority, having on the land side the appearance of a broadened truncated cone. The sands on the top and on the landward slope of this dune (being about 100 yards from the sea) possess remarkable acoustic properties, likened to the bark of a dog. The dune has a maximum height of 108 feet, but the slope of sonorous sand is only 60 feet above the level field on which it is encroaching. At its steepest part, the angle being quite uniformly 31°, the sand has a notable mobility when perfectly dry, and on disturbing its equilibrium, it rolls in wavelets down the incline, emitting at the same time a deep bass note of a tremulous character. My companion thought the sound resembled the hum of a buzz saw in a planing mill. A vibration is sometimes perceived in the hands or feet of the person moving the sand. The magnitude of the sound is dependent upon the quantity of sand moved, and probably to a certain extent upon the temperature. The drier the sand the greater the amount possessing mobility, and the louder the sound. At the time of my visit the sand was dry to the depth of four or five inches; its temperature three inches beneath the surface was 87° F., that of the air being 83° in the shade (4:30 P.M.)

When a large mass of sand was moved downward, I heard the sound at a distance of 105 feet from the base, a light wind blowing at right angles to the direction. On one occasion horses standing close to the base were disturbed by the rumbling sound. When the sand is clapped between the hands a slight hoot-like sound is heard; but a louder sound is produced by confining it in a bag, dividing the contents into two parts and bringing them together violently. This I had found to be the best way of testing seashore sand as to its sonorousness. The sand on the top of the dune is wind furrowed, and generally coarser than that of the slope of 31°, but this also yielded a sound of unmistakable character when so tested. A bag full of sand will preserve its power for some time, especially if not too frequently manipulated. A creeping vine with a blue or purple blossom (*kolokolo*) thrives on these dunes, and interrupts the sounding slope. I found the main slope 120 feet long at its base; but the places not covered by this vine gave sounds at intervals 100 paces westward. At 94 paces further the sand was non-sonorous.

The native Hawaiians call this place *Nohili*, a word of no specific meaning, and attribute the sound caused by the sand to the spirits of the dead, *uhane*, who grumble at being disturbed; sand dunes being commonly used for burial places, especially in early times, as bleached skeletons and well preserved skulls at several places abundantly show.

Sand of similar properties is reported to occur at *Haula*, about three miles east of Koloa, Kauai; this I did not visit, but, prompted by information communicated by the Hon. Vladimar Knudsen, of Waiawa, I crossed the channel to the little-visited island of Niihau. On the western coast of this islet, at a place called *Kaluakahua*, sonorous sand occurs on the land side of a dune about 100 feet high, and at several points for 600 to 800 feet along the coast. On the chief slope, 36 feet high, the sand has the same mobility, lies at the same angle, and gives when disturbed the same note as the sand of Kauai, but less strong, the slope being so much lower. This locality has been known to the residents of the island for many years, but has never been before announced in print. This range of dunes, driven before the high winds, is advancing southward, and has already covered the road formerly skirting the coast.

The observations made at these places are of especial interest, because they confirm views already advanced by Dr. Julien and myself with regard to the identity of the phenomena on sea beaches and on hill sides in arid regions (*Jebel Nagous, Rig-i-Rawan*, etc.) The sand of the Hawaiian Islands possesses the acoustic properties of both classes of places; it gives out the same note as that of Jebel Nagous when rolling down the slope, and it yields a peculiar hoot-like sound when struck together in a bag, like the sands of Eigg, of Manchester, Mass., and other sea beaches—a property that the sand of Jebel Nagous does not possess. These Hawaiian sands also show how completely independent of material is the acoustic quality, for they are wholly carbonate of lime, whereas sonorous sands of all other localities known to us (now over one hundred in number) are siliceous, being either pure silex or a mixture of the same with silicates, as feldspar.

The theory proposed by Dr. Julien and myself to explain the sonorousness has been editorially noticed in *Nature*, but may properly be briefly stated in this connection. We believe the sonorousness in sands of sea beaches and of deserts to be connected with thin pellicles or films of air, or of gases thence derived, deposited and condensed upon the surface of the sand grains during gradual evaporation after wetting by the seas, lakes, or rains. By virtue of these films the sand grains become separated by elastic cushions of condensed gases, capable of considerable vibration, and whose thickness we have approximately determined. The extent of the vibrations, and the volume and pitch of the sounds thereby produced after any quick disturbance of the sand, we also find to be largely dependent upon the forms, structures, and surfaces of the sand grains, and especially upon their purity, or freedom from fine silt or dust (Proceedings Am. Assoc. Adv. Sci., 38, 1889).

I should be lacking in courtesy if I closed this letter without expressing my great obligations to Mr. H. P. Faye, of Mana, and to Mr. Geo. S. Gay, of Niihau, for both a generous hospitality and a sympathetic assistance in carrying out my investigations.

H. CARRINGTON BOLTON.

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